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Resource and Capital Requirement Matrices for the California Economy

PINHAS ZUSMAN
and
IRVING HOCH

CALIFORNIA AGRICULTURAL EXPERIMENT STATION
GIANNINI FOUNDATION OF AGRICULTURAL ECONOMICS

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FOREWORD AND ACKNOWLEDGMENTS

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TABLE OF CONTENTS

Page

I. INTRODUCTION 1

A. Purpose of This Study 1

B. Outline of Tables Appearing in This Study 2

C. Outline of Topics Covered 6

II. FLOW AND COEFFICIENT TABLES: STATEMENT OF RESULTS 7

A. Current Output and Replacement Matrices 7

The Sectors of the Economy 7

The Revised Matrix of Gross Flows 8

The Gross Technical Coefficient Matrix 14

B. Primary Resources Coefficients 14

Basic Relationships 14

Labor Coefficients 18

Land and Irrigated Land Coefficients 20

Water Coefficients 20

Levels of Available Primary Resources 25

C. Capital Coefficients 29

Definitions and Basic Concepts 29

Derivation of Capital Stock Coefficients 31

Derivation of Inventory Coefficients 35

Page

Combined Capital Coefficients and Investment Matrix 39

D. Replacement Flows 43

III. DETAILED DESCRIPTION OF DERIVATION OF MATRICES 52

A. Derivation of Primary Resources Coefficients 52

Labor Coefficients 52

Land and Irrigated Land Coefficients 54

Water Coefficients 55

B. Derivation of Capital Stock Coefficients 56

Agricultural Sectors 56

Nonagricultural Sectors 62

The Irrigated Land Activity 67

C. Derivation of Inventory Coefficients for Individual Sectors 67

Agricultural Sectors 67

Nonagricultural Sectors 75

D. Derivation of Replacement Flows for Individual Sectors 78

Initial Calculations 78

The Irrigated Land Activity 83

General Adjustment of Replacement Flows 84

LITERATURE CITED 85

LIST OF TABLES

Table Page

1 Gross Interindustry Flows, 1954 9

2 Gross Technical Coefficients, 1954: A Matrix 15

3 Labor Requirements and Coefficients: Primary Resources Matrix, California (1954 Base Year) 19

4 Land Coefficients: Primary Resources Matrix, California (1954 Base Year) 21

5 Investment and Replacement Costs for Irrigated Land, California (1954 Base Year) 22

6 Water Coefficients: Primary Resources Matrix, California (1954 Base Year) 24

7 Levels of Primary Resources, California, 1954 28

8 Capital Stock Coefficients Matrix, California (1954 Base Year) 32

9 Inventories: Raw Materials and Goods-in-Process Coefficients Plus Finished Goods Coefficients, California (1954 Base Year) 36

10 Combined Capital Coefficient Matrix, California (1954 Base Year) 40

11 Modified Capital Coefficients, California (1954 Base Year) 44

12 Investment Coefficients: W Matrix, California (1954 Base Year) 45

13 Replacement Flows, California (1954 Base Year) 49

RESOURCE AND CAPITAL REQUIREMENT MATRICES FOR THE CALIFORNIA ECONOMY

by

Pinhas Zusman[1] and Irving Hoch[2]

I. INTRODUCTION

A. Purpose of This Study

Empirical input-output tables, in the usual sense of tables based on current flows of outputs between sectors, can be used as descriptive devices, in the development of projections, or as planning tools. It can be argued that extensions of the usual tables, bringing in additional flow and coefficient relationships, will be useful in any of the functions noted above. This argument is a basis for the present study which is concerned with such extensions.

This study draws on and builds upon the input-output work of Martin and Carter; their work on the California economy consists of tables based on current flows between sectors. Martin's dissertation (35) is an important source document for the present work, and the report by Martin and Carter (36) presents much of this material in readily accessible form.[3] The industrial classification developed by Martin and Carter is employed here; further measures appearing here were developed in line with their definitions and classification.

This study develops additional tables furnishing information on resources and capital requirements by California industries with particular emphasis on California agriculture. In addition, modified matrices of current flows are presented with the modification involving the introduction of replacement flows for capital used up in the production process. The base year for the Martin and Carter tables is 1954, and the same base year is employed for the tables developed in the present study.

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[1] Formerly Assistant Research Specialist, Agricultural Experiment Station, University of California, Berkeley. Presently on the Faculty of Agriculture, Hebrew University, Rehovot, Israel.

[2] Associate Professor of Agricultural Economics and Associate Agricultural Economist in the Experiment Station and on the Giannini Foundation, University of California, Berkeley.

[3] Numbered references in parentheses refer to Literature Cited.

There is some discussion of possible application of the tables developed here, but the major purpose of the present report is the presentation and documentation of the tables as such. Hence, this report can be viewed as a "background" document on the development of empirical measures to be applied in later investigations. Some specific applications are contemplated by the authors; it is hoped, however, that material presented here will be of interest of itself and that it will be useful in a variety of applications.[1]

B. Outline of Tables Appearing in This Study

In the usual input-output approach, we have a flow table with elements X^*_{ij}, where X^*_{ij} is output flow from sector i to j, with i, j = 1, 2, ..., n. A subset of m sectors is treated as endogenous, and we form the matrix of technical coefficients:[2]

$$A^* = \left(\frac{X^*_{ij}}{X^*_j}\right)$$

with i, j = 1, ..., m, $m < n$, and X^*_j = total output of industry j. The use of X^*_j denotes division by the row sum $\sum_{k=1}^{n} X^*_{jk}$ (for endogenous rows, j = 1, ..., n). In practical work, for each endogenous sector, we usually have row sum equal to column sum; that is, $\sum_{k=1}^{n} X^*_{jk} = \sum_{k=1}^{n} X^*_{kj}$, where the sum over both row and column includes exogenous sectors.

---

[1] A specific application by Ivan M. Lee may be noted. In "Conditional Projections of California Economic Growth" (manuscript in preparation for publication), Professor Lee makes use of some of the tables of this report in developing conditional projections for the California economy. Additional applications are anticipated in the work of Giannini Foundation Project 1781.

[2] In practical work, we may find i = 1, 2, ... m, m + 1, ... n, while j = 1, 2, ... m, ... N so that our original flow matrix is of size n x N. This occurs because some of the exogenous industries are aggregated in different ways in terms of defining row and column sectors. However, in any event, the endogenous sectors form an m x m square submatrix.

Then it can be shown that:

$$(I - A^*)X^* = y^*$$

where

X^* = the column vector (X_i^*), $i = 1, \ldots, m$.

y^* = the column vector of final demand on industry i, with $y_i^* = \sum_{j=m+1}^{n} X_{ij}^*$.

A^* = the technical coefficient matrix of size m x m.

The matrix $(I - A^*)^{-1} = B^*$, or the matrix of interdependence coefficients of size m x m, can then be formed. A given column vector of $B^* = (b_j^*)$ indicates the ultimate effect of an expansion of $1.00 in final demand for the product of industry j, in terms of the increment of production required from industry i (in the amount of b_{ij}^*). $\sum_i b_{ij}^*$ can be viewed as the total multiplier effect of the original $1.00 increase in final demand for the product of industry j. Specific matrices corresponding to $(X_{ij}^*)_{(n \times n)}$, $A^*_{(m \times m)}$, and $B^*_{(m \times m)}$ are developed in Martin's dissertation (35) for the California economy. The following additional matrices were developed in the present study (with 1954 as the base year in all cases):

1. A current flow matrix introducing replacement flows as well as output flows. Let D_{ij} denote output from i used in j to replace capital worn out in production. Then we form $(X_{ij}) = (X_{ij}^* + D_{ij})$ and a variant technical coefficient matrix $A = \left(\frac{X_{ij}}{X_j}\right)$, based on the combined flow matrix (X_{ij}) with $X_j = \sum_k^n X_{jk}$.[1]
2. A primary resources coefficient matrix, which exhibits primary resources required as inputs per unit of output by individual industry.[2] The coefficient matrix may be written:

$$R = (r_{pj}) = \left(\frac{z_{pj}}{X_j}\right) \qquad \begin{array}{l} p = 1, 2, \ldots, P \\ j = 1, 2, \ldots, n \end{array}$$

---

[1] It should be noted $\sum_k X_{jk}^* = \sum_k X_{jk}^*$, or output totals (row sums X_i and X_i^*), are equal. This is because the corresponding sum $\sum_j D_{ij}$ is subtracted from gross private capital formation for sector i.

[2] Primary resources include land, labor, and water.

where z_{pj} is the total amount of resource p used by industry j in producing X_j.

Hence,

r_{pj} = the amount of resource p required per unit of output by industry j.

R = the p x n matrix of resource requirements coefficients.

The R matrix may be useful in a variety of applications. A particular application might be in the analysis of economic growth; the resource requirements coefficients may well impose restrictions on growth. Thus, assuming R to be stable over time, we might view available resources in time t as a restriction on total production,[1] so that a relation of the form $RX_t \leq Z_t$ might be viewed as appropriate, where Z_t is a vector of resource availabilities in year t with Z_t of size P x 1. A particular element, Z_{pt}, is the amount of the resource p available (or projected as available) in year t.[2]

3. A set of "capital" coefficient matrices consisting of (a) a capital stock coefficient matrix (capital goods required to increase output by one unit, by industry), (b) an inventory coefficient matrix (inventory requirements per unit of output, by industry), and (c) an overall capital coefficient matrix formed by the addition of capital stock and the inventory coefficient matrices.

   More precisely, the capital stock coefficient matrix consists of the value of capital goods (buildings, machinery, equipment, etc.) needed to achieve a unit of additional output, given that total capital is a constraint on industry output and that the industry is operating at its output maximum. For output below this maximum, the level of output can be increased without additions to capital stock. For output above this level, additional capital stock is required. A unit of capital stock, of course, will generate a flow of output over time, that is, beyond one production period. Symbolically, we may write

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[1] The time subscript t allows reference to years other than the base year; for the base year, values obtained for z_{pj} and X_j were used to construct R.

[2] It may be noted that exogenous sectors have been included in the statement of the resources coefficient matrix. Hence, in the inequality presented above, X_t is of size n x 1. In some applications, exogenous sectors might be excluded, so that we would have $R_{(p \times m)}$ and $X_{t(m \times 1)}$. In these applications, an accounting for resources used by exogenous sectors would be appropriate so that Z_t would then be modified.

$$K = K^1 + K^2$$

where

K = the overall capital stock coefficient matrix.

K^1 = the capital stock coefficient matrix.

K^2 = the inventory coefficient matrix.

Then, k_{ij} is the amount of total capital goods (including inventory items) produced by industry i which is required by industry j to achieve a unit expansion of output of industry j, with $K = \{k_{ij}\}$, and i, j = 1, 2, ..., n.

The capital coefficients, like the resource coefficients, may be applicable in a variety of contexts. Again, the analysis of economic growth could be a particular application. In this context, some or all of the capital coefficients may impose restrictions on growth. Thus, the investigator might want to specify the inequality

$$Q_t^1 \geqq \lambda^1 X_t$$

where

$Q^1_{t(n \times 1)}$ = a vector of capital stocks by industry of use.

λ^1 = a diagonal matrix of summed capital stock coefficients; that is, $\lambda^1_{jj} = \sum_i k^1_{ij}$.

$X_{t(n \times 1)}$ = the vector of outputs.[1/]

An alternative set of specific restrictions on output might take the form:

$$Q_t \geqq \lambda X_t$$

[1/] As in the case of the resources coefficient matrix, exogenous sectors are included in the capital coefficient matrices. Hence, X_t is of size n x 1 in this presentation.

where

Q_t = a vector of all capital used (both stocks and inventories)

and

λ = a diagonal matrix of summed capital coefficients ($\lambda_{jj} = \Sigma_i k_{ij}$).

In the first inequality, it is specified that capital stocks relative to output are equal to or greater than the given proportion in the capital coefficient matrix. Inventories are assumed to bear a constant proportion to output.

In the second inequality, it is specified that the sum of capital stocks and inventories relative to output are equal to or greater than the given proportion.

Whether one of these specifications or an alternative specification is adopted will depend on the particular features of the problem being investigated and on the assumptions the investigator deems most reasonable for that problem.

C. Outline of Topics Covered

In part II, the tables previously outlined are presented and described, and a summary of operations involved in developing these tables is presented. In addition, some potential applications are noted. Section A of part II is devoted to the current output and replacement matrices; section B covers the primary resources coefficient matrix; section C deals with the capital coefficient matrices; and section D involves an extended discussion of replacement flows.

Part III contains detailed documentation on the construction and derivation of each of the matrices presented. A sector-by-sector description appears, with organization parallel to that of part II. Particular sections (in order) are devoted to primary resources, capital stock coefficients, inventory coefficients, and replacement flows, respectively.

II. FLOW AND COEFFICIENT TABLES: STATEMENT OF RESULTS

A. Current Output and Replacement Matrices

The Sectors of the Economy

The Martin UC classification of sectors of the economy is followed, in this study, with the term "UC sector i" used to refer to the *i*th sector of the economy.

The UC classification consists of the following:[1]

1. Meat animals and products.
2. Poultry and eggs.
3. Farm dairy products.
4. Food and feed grains.
5. Cotton.
6. Vegetables.
7. Fruits and nuts (excluding citrus).
8. Citrus.
9. Forage.
10. Miscellaneous agriculture.
11. Grain mill products.
12. Meat and poultry processing.
13. Dairy products.
14. Canning, preserving, freezing.
15. Miscellaneous agricultural processing.
16. Chemicals and fertilizers.
17. Petroleum.
18. Fabricated metals and machinery.
19. Aircraft and parts.
20. Primary metals.
21. Other manufacturing.
22. Mining.
23. Utilities.
24. Selected services.
25. Trade and transportation.
26. Unallocated services.
27. Scrap and by-products.
28. Net imports.
29. Maintenance construction.
30. New construction.

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[1] The notation "UC sector" was introduced by Martin (35) and appears in the Martin and Carter study (36). An explanation of the usage and statement of industry subcategories, by sector, appear in (36), Part II, pp. 1-3. Carter and Martin note that "the 'UC study' or 'UC model' refers to the present 1954 California model" in (36), footnote 1, p. 2. The usage, of course, refers to the industrial classification developed by Martin and Carter for *their* California model. Other University of California investigators might employ a quite different industrial classification scheme, depending on their interests and the problem at hand.

31. State and local governments.
32. Federal government.
33. Inventory additions.
34. Inventory depletions.
35. Gross private capital formation.
36. Farm households.
37. Other households.

In the Martin study, sectors 33 through 37 appear as columns only, reflecting the underlying U. S. Bureau of Labor Statistics study (63) used as a source document. In the present study, sectors 29 and 30 are combined into an overall construction sector, while sectors 36 and 37 are combined into an overall household sector.

The Revised Matrix of Gross Flows

A matrix of current flows is the usual initial table in input-output analysis. A matrix of gross flows is the initial table here.

Let X_{ij} be the value of the product of sector i used as input in sector j. This value includes both current flows and flows purchased to replace capital goods used up in the productive process. These flows may be produced domestically or outside the local economy (California, in this case); that is, competitive imports as well as domestic production are included in the individual element X_{ij}. The matrix (X_{ij}), designated the matrix of gross flows, appears as Table 1. As in the Martin and Carter tables, measures here refer to 1954 as the base year.

The matrix of gross flows was derived as follows. Martin developed a table of current account transactions, a given element representing a flow of current production from sector i to sector j, with domestic (California) production and competitive import (production from outside California) combined in one figure. We may label this X^*_{ij}. To each element in this matrix of current flows there is added the corresponding estimate of replacement flow. Replacement flow is the amount of investment needed to replace capital goods used up in the production process. The estimates of replacement flows are contained in a table in part II, section D.[1/] Let us label a particular element of replacement flow as D_{ij}. Then, the addition of D_{ij} to X^*_{ij} is carried out with offsetting subtractions so that row and column totals are unaffected. Thus,

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1/ See Table 13, p. 49.

TABLE 1

Gross Interindustry Flows, 1954

UC classification--industry of origin	UC classification--industry of destination 1	2	3	4	5	6	7	8	9
	thousand dollars								
1	a/								
2		57,363							
3			9,325						
4	15,789	26,264	8,288	9,308					
5					1,084				
6						5,562			
7									
8								2	
9	91,016		81,371						
10	107		1,976	8,109	28,939	16,206	13,260	3,507	10,391
11	17,366	118,766	34,343						
12									
13									
14									
15									
16	1,355	1,516	1,676	13,337	15,219	13,635	20,554	4,792	7,086
17	855	1,195	1,259	4,056	2,064	4,014	9,732	1,952	3,053
18	2,015	5,207	7,860	23,158	23,955	17,747	27,384	7,679	22,170
19									
20									
21	846	12,035	1,584	905	868	24,692	10,424	6,459	783
22				21	61	76	164	38	57
23	1,523	1,742	1,485	583	838	1,353	3,153	744	312
24	820	1,661	1,316	3,937	1,877	3,870	8,951	1,993	3,552
25	16,141	31,143	15,345	17,404	17,280	24,116	20,542	7,316	13,395
26	2,553	5,268	7,268	1,685	2,259	2,770	5,915	2,436	2,302
27	9,293	945	6,304						
28	113,270		10,475						
29-30	5,218	8,813	9,676	2,856	4,262	4,424	2,762	1.065	2,161
31	5,667	4,665	10,663	7,763	6,546	9,797	11,577	4,700	10,123
32	283	886	613	1,117	1,614	2,239	2,075	768	1,261
36-37	52,764	34,748	132,716	103,490	177,463	357,338	203,149	93,566	104,557
Gross domestic output	336,881	312,217	343,543	197,729	284,329	487,839	339,642	137,017	181.203

(Continued on next page.)

TABLE 1--continued.

UC classification--industry of origin	UC classification--industry of destination								
	10	11	12	13	14	15	16	17	18
	thousand dollars								
1			562,638						
2			62,851	32	6	2,655			
3				276,821					
4	385	133,191				3,419	100		
5									
6					154,636	7,735			
7					207,818	45,384	180		
8					13,440				
9	7,062	6,732							
10	8,081				68,074	48,620	4,735		
11	138	27,741	277	198	9,418	92,816	2,343		5
12	500	2,406	51,016	1,941	17,200	26,682	19,934	7	
13		1,118	992	55,717	1,080	15,824	641		
14		1,067	2,217	1,014	19,614	11,254	932		
15	1,104	13,932	5,633	24,342	105,591	343,626	16,654	2	15
16	7,857	6,823	8,221	3,169	29,928	118,610	300,200	49,160	54,128
17	8,568	621	984	1,317	1,385	4,699	20,289	1,064,867	9,619
18	26,162	5,410	12,667	13,796	119,847	44,991	26,440	80,506	1,141.316
19									2,669
20							13,691	1,666	626,644
21	8,326	21,648	6,759	15,738	83,508	79,655	40,618	39,521	252,761
22	27	56				222	11,496	1,954	1,066
23	3,244	2,266	3,636	4,754	7,556	17,387	13,222	23,149	34,106
24	5,931	1,136	2,267	3,721	9,050	15,666	2,751	9,617	12,421
25	16,766	28,240	27,284	20,652	35,544	79,033	34,496	131,324	150,807
26	3,986	7,590	5,356	6,091	40,103	57,410	34,041	39,217	55,281
27	301	39,622	45,357				42,412	9	4,049
28	195		1,632			109,062	10,764	511	8,891
29-30	3,473	1,127	3,658	3,523	9,624	12,973	4,182	55,218	27,405
31	8,735	1,249	1,935	4,088	9,121	14,209	5,841	64,703	23,738
32	2,295	8,197	9,683	12,643	46,195	74,557	42,374	150,422	190,863
36-37	181,642	93,526	211,126	121,072	232,603	500,654	216,938	1,148,834	1,401,730
Gross domestic output	294,778	403,698	1,026,189	570,629	1,221,341	1,727,143	865,274	2,860,687	3,997,514

(Continued on next page.)

TABLE 1--continued.

UC classification--industry of origin	UC classification--industry of destination								
	19	20	21	22	23	24	25	26	27
	thousand dollars								
1			26						147
2									
3									45,357
4									
5			1,117						35,561
6									1,724
7									
8									
9									
10			2,961						40
11		158			5	11,513	602	1,066	1,057
12			2,306		688	92,207	2,049	17,493	33,163
13			429		417	70,824	4,623	6,263	
14					263	46,308	704	4,213	314
15		5	1,854		712	207,112	23,793	12,083	4,587
16	30,632	4,921	137,815	12,099	1,273	39,573	21,964	51,103	51,455
17	17,416	18,114	27,924	6,604	80,180	24,822	129,396	135,634	1,231
18	637,433	29,891	200,100	20,465	76,313	351,815	364,273	46,318	17,905
19	416,166					788	15,712		10,772
20	376,912	339,951	64,379	7,101	2,261	331	26,853	4,559	16,629
21	252,680	14,596	1,389,739	9,421	16,669	168,140	254,788	698,273	8,718
22		22,512	28,109	4,306			423		
23	53,908	15,827	65,507	12,160	208,045	114,735	183,900	579,982	
24	16,437	2,250	23,562	7,900	8,663	183,135	201,317	93,237	
25	98,622	41,440	215,428	10,536	49,098	280,579	362,481	359,886	
26	70,919	8,153	85,215	6,330	28,641	305,299	735,718	691,387	
27		67,111	16,367		851				
28	25,737	72,097	17,243	452	7,370	41	52,763	639	
29-30	38,295	22,284	40,662	3,078	134,698	142,317	294,660	2,114,352	
31	15,239	5,410	31,999	19,815	159,515	135,309	341,573	995,272	
32	109,473	35,597	236,724	12,796	111,795	244,741	558,651	238,030	
36-37	2,389,738	195,511	2,020,783	173,046	701,764	2,014,523	4,576,387	4,163,235	
Gross domestic output	4,549,607	895,828	4,610,249	306,109	1,589,221	4,434,112	8,152,630	10,213,025	228,660

(Continued on next page.)

TABLE 1--continued.

UC classification--industry of origin	UC classification--industry of destination							Gross domestic output
	28	29-30	31	32	33-34	35	36-37	
	thousand dollars							
1	247,834				18,532		3,372	336,881
2	1,637		450		13		187,210	312,217
3					2,044		9,996	343,543
4	25,384				26,369			197,729
5	227,897				18,670			284,329
6	141,307		529		7,572		183,918	487,839
7	49,766		528		658		35,308	339,642
8	108,603		25				14,947	137,017
9	2,958				2,020			181,203
10	44,614				4,060		31,098	294,778
11	43,653		216		433		128,890	403,698
12	190,940		4,392		2,246		947,391	1,026,189
13	95,350		2,263		1,057		506,845	570,629
14	826,736		1,048		18,983		286,674	1,221,341
15	178,535	322	2,097		5,692		1,136,522	1,727,143
16	510,354	116,047	6,871		959		243,650	865,274
17	601,456	113,461	9,857		568	1	554,630	2,860,687
18	1,579,562	1,007,473	40,374		11,345	56,801	1,130,950	3,997,514
19	4,103,078		17		2,242	1,217	1,430	4,549,607
20	901,219	313,029	83		638		2,320	895,828
21	2,296,486	957,784	38,559		3,019	4,787	2,488,470	4,610,249
22	155,609	72,242	50				7,620	306,109
23	98,179	15,468	40,750	47,475			228,590	1,589,221
24	552,025	139,989	15,239	10,851			3,088,970	4,434,112
25	264,277	895,550	16,037	303,264		16,084	4,552,520	8,152,630
26	120,000	209,224	892,825	394,704		102,429	6,280,650	10,213,025
27	10,394	6,061			372			228,660
28		171	924			36.808	110,470	579,515
29-30		5,270	1,073,456	409.830		2,005,711	21,285	6.468.318
31		32,329	134,013	360,374		680	1,526,803	3,963,451
32		86,952		16,426		13,952	3,266,036	5,479,258
36-37		2,496,946	1,566,227	3,649,000		124,422	322,610	29,762,108
Gross domestic output	1,016,157	6,468,318	3,846,830	5,191,924	67,354	2,362,892	27,299,175	96,819,744

a/ Blanks indicate zero or approximately zero flows.

there is a corresponding subtraction of D_{ij} from the ith row entry in the "gross private capital formation sector" (the UC 35 column). Further, there is a corresponding subtraction of D_{ij} from the jth column entry in the household row (UC 36-37). The latter operation is appropriate since depreciation is one of the components of the household row. (In practice, of course, $\sum_j D_{ij}$ is subtracted from the ith element in column UC 35, and $\sum_i D_{ij}$ is subtracted from the jth element of the combined row UC 36-37.)

The approach used here assumes replacement requirements are proportional to the level of output. This is a defensible assumption if output is stable or increasing over time since it involves the idea that capital is used up (depreciated) and is then replaced in proportion to output. If output decreases, however, the assumption becomes less defensible, since there may be a corresponding reduction in capital with little or no replacement of depreciated capital. (The reduction in capital can be carried out by not replacing depreciated capital.) Given increasing population and income and highly aggregated industries, it seems very unlikely that output of any sector will decline over time.[1] Hence, the proportionality assumption seems acceptable. A detailed discussion of the development of the table on replacement flows is deferred until after discussion of the development of capital coefficients.[2]

The flows in Table 1 are equivalent to those presented in Table I-I of the Martin and Carter report (36), Appendix A, p. 80, but with the following modifications:

1. Competitive imports have been redistributed; in each column, competitive imports have been distributed from (row) sector 28 to the sectors (rows) of origin.[3]
2. Replacement flows have been redistributed as indicated above.
3. Where necessary, modifications in the UC 35 column entries were carried out.

---

[1] In a less aggregated set of sectors, specific industries might be faced with declining demand and declining output.

[2] *Infra*, pp. 56-67.

[3] The flows resulting from the redistribution of imports are those presented in Martin and Carter tables, "Available Supply and Distribution of . . . 1954" (36), Part II.

If we let X_j equal the value of gross domestic output of the jth industry, we note that X_j for Table 1 here equals X_j presented in the Martin and Carter Table I-I. Also, row totals here equal column totals by virtue of negative entries in column UC 28 representing net imports.

The Gross Technical Coefficient Matrix

Given that X_j is the value of gross domestic output, the "gross technical coefficient" a_{ij} is defined by:

$$a_{ij} = \frac{X_{ij}}{X_j} = \frac{X^*_{ij} + D_{ij}}{X_j}$$

with the "gross technical coefficient matrix" denoted:

$$A = \left\{a_{ij}\right\} .$$

The A matrix is presented in Table 2. For a given column of Table 1, the entries in that column are divided by gross domestic output to obtain the corresponding elements of the A matrix. In the case of government sectors (UC 31 and UC 32), gross domestic output is taken as the row sum for the respective sector.

B. Primary Resources Coefficients

Basic Relationships

At a given point in time, the available supply of scarce primary resources is one of the determinants of output by the sectors of an economy. Available resources can be viewed as imposing restrictions on output; such restrictions can be expressed formally by a set of linear inequalities:

$$RX_t \leq Z_t$$

where

$X_{t(n \times 1)}$ = the vector of outputs by sector.

$Z_{t(p \times 1)}$ = a vector of available primary resources in time t, assuming p categories of primary resources. (In this formulation, a particular category could be a subcategory of another category; this would be appropriate if one resource restriction applied to the category as a whole while a second restriction applied to a subcategory; for example, an investigator might be concerned with both total labor availability and with farm labor availability.)

TABLE 2

Gross Technical Coefficients, 1954: A Matrix

UC classification--industry of origin	UC classification--industry of destination										
	1	2	3	4	5	6	7	8	9	10	11
	dollar per dollar										
1	a/										
2		.183728									
3			.027144								
4	.046868	.084120	.024125	.047075						.001306	.329927
5					.003812						
6						.011401					
7											
8								.000015			
9	.270173		.236858							.023957	.016676
10	.000318		.005752	.041011	.101780	.033220	.039041	.025595	.057344	.027414	
11	.051549	.380396	.099967							.000468	.068717
12										.001696	.005960
13											.002769
14											.002643
15										.003745	.034511
16	.004022	.004856	.004879	.067451	.053526	.027950	.060517	.034974	.039105	.026654	.016901
17	.002538	.003827	.003665	.020513	.007259	.008228	.028654	.014246	.016849	.029066	.001538
18	.005981	.016678	.022879	.117120	.084251	.036379	.080626	.056044	.122349	.088752	.013401
19											
20											
21	.002511	.038547	.004611	.004577	.003053	.050615	.030691	.047140	.004321	.028245	.053624
22				.000106	.00215	.000156	.000483	.000277	.000315	.000092	.000139
23	.004521	.005579	.004323	.002948	.002947	.002773	.009283	.005430	.001722	.011005	.005613
24	.002434	.005320	.003831	.019911	.006602	.007933	.026354	.014546	.019602	.020120	.002814
25	.047913	.099748	.044667	.088019	.060775	.049434	.060481	.053394	.073923	.056876	.069953
26	.007578	.016873	.021156	.008522	.007945	.005678	.017415	.017779	.012704	.013522	.018801
27	.027585	.003027	.018350							.001021	.098148
28	.336231		.030491							.000662	
29-30	.015489	.028227	.028165	.014444	.014990	.009069	.008132	.007773	.011926	.011782	.002792
31	.016822	.014942	.031038	.039261	.023023	.020082	.034086	.034302	.055866	.029632	.003094
32	.000840	.002838	.001784	.005649	.005677	.004590	.006109	.005605	.006959	.007786	.020305
36-37	.156625	.111294	.386316	.523393	.624147	.732492	.598126	.682879	.577016	.616199	.231673
Subtotal, 1-32	.843373	.888706	.613685	.476607	.375855	.267508	.401872	.317120	.422985	.383801	.768326

(Continued on next page.)

TABLE 2--continued.

UC classification--industry of origin	UC classification--industry of destination										
	12	13	14	15	16	17	18	19	20	21	22
	dollar per dollar										
1	.548279									.000006	
2	.061247	.000056	.000005	.001537							
3		.485116									
4				.001980	.000116						
5										.000242	
6			.126612	.004478							
7			.170156	.026277	.000208						
8			.011004								
9											
10			.055737	.028151	.005472					.000642	
11	.000270	.000347	.007711	.053740	.002708		.000001		.000176		
12	.049714	.003402	.014083	.015449	.023038	.000002				.000500	
13	.000967	.097641	.000884	.009162	.000741					.000093	
14	.002160	.001777	.016059	.006516	.001077						
15	.005489	.042658	.086455	.198956	.019247	.000001	.000004		.000005	.000402	
16	.008011	.005554	.024504	.068674	.346942	.017185	.013540	.006733	.005493	.029893	.039525
17	.000959	.002308	.001134	.002721	.023448	.372242	.002406	.003828	.020220	.006057	.021574
18	.012344	.024177	.098127	.026049	.030557	.028142	.285506	.140107	.033367	.043403	.066855
19							.000668	.091473			
20					.015823	.000582	.156758	.082845	.379482	.013964	.023198
21	.006587	.027580	.068374	.046120	.046942	.013815	.063230	.055539	.016293	.301446	.030777
22				.000129	.013286	.000683	.000267		.025130	.006097	.014067
23	.003543	.008331	.006187	.010067	.015281	.008092	.008532	.011849	.017667	.014209	.039724
24	.002209	.006521	.007410	.009070	.003179	.003362	.003107	.003613	.002512	.005111	.025808
25	.026588	.036192	.029102	.045759	.039867	.045906	.037725	.021677	.046259	.046728	.034419
26	.005219	.010674	.032835	.033240	.039341	.013709	.013829	.015588	.009101	.018484	.020679
27	.044199				.049016	.000003	.001013		.074915	.003550	
28	.001590			.063146	.012440	.000179	.002224	.005657	.080481	.003740	.001477
29-30	.003565	.006174	.007880	.007511	.004833	.019302	.006856	.008417	.024875	.008820	.010055
31	.001886	.007164	.007468	.008227	.006750	.022618	.005938	.003350	.006039	.006941	.064732
32	.009436	.022156	.037823	.043168	.048972	.052582	.047745	.024062	.030736	.051347	.041802
36-37	.205738	.212173	.190449	.289874	.250716	.401594	.350650	.525262	.218246	.438324	.565308
Subtotal, 1-32	.794262	.787828	.809550	.710127	.749284	.598405	.649349	.474738	.781751	.561675	.434692

(Continued on next page.)

TABLE 2--continued

UC classification--industry of origin	UC classification--industry of destination								
	23	24	25	26	27	28	29-30	31	32
	dollar per dollar								
1					.000642				
2								.000114	
3					.198360				
4									
5					.155519				
6					.007540			.000133	
7								.000133	
8								.000006	
9									
10					.000175				
11	.000003	.002596	.000074	.000104	.004623			.000054	
12	.000433	.020795	.000251	.001713	.145032			.001108	
13	.000262	.015973	.000567	.000613				.000571	
14	.000165	.010444	.000086	.000413	.001373			.000264	
15	.000448	.046709	.002918	.001183	.020060		.000050	.000529	
16	.000801	.008925	.002694	.005004	.225028		.017941	.001734	
17	.050452	.005598	.015872	.013280	.005384		.017541	.002487	
18	.048019	.079343	.044682	.004535	.078304		.155755	.010187	
19		.000178	.001927		.047109			.000004	
20	.001423	.000075	.003294	.000446	.072724		.048394	.000021	
21	.010489	.037920	.031252	.068371	.038126		.148073	.009729	
22			.000052				.011169	.000013	
23	.130910	.025876	.022557	.056788			.002391	.010281	.008664
24	.005451	.041301	.024694	.009129			.021642	.003845	.001980
25	.030894	.063277	.044462	.035238			.138452	.004046	.055348
26	.018022	.068852	.090243	.067697			.032346	.225265	.072036
27	.000535						.000937		
28	.004637	.000009	.006472	.000063			.000026	.000233	
29-30	.084757	.032096	.036143	.207025			.000815	.270839	.074797
31	.100373	.030515	.041897	.097451			.004998	.033812	.065771
32	.070346	.055195	.068524	.023307			.013443		.002998
36-37	.441577	.454324	.561339	.407640			.386027	.395167	.665966
Subtotal, 1-32	.558420	.545677	.438661	.592360	.999999		.613973	.575408	.281594

a/ Blanks indicate zero or approximately zero flows.

$R_{(p \times n)}$ = a matrix of resource requirement coefficients measured in primary resources units (acres, employees, etc.) per thousand dollars of gross domestic output.

In the R matrix, then, a given row expresses the input requirements for a particular resource by individual sectors of the economy, corresponding to columns of the given row. The development of the R matrix may be of interest in and of itself; it may yield a set of restrictions of use in analytical models; and it may furnish information for extension of the usual input-output framework to include "resource sectors."

In the present study, primary resources specified are labor, land, irrigated land, and water. We report here on the development of rows of the R matrix for these resources. In addition, the production of irrigated land can be viewed as an investment activity, and a vector of investment costs per acre is developed and presented. Primary resources coefficients were estimated for the year 1954 for consistency with the basic flow table and A matrix.

Labor Coefficients

Let L_j = total civilian labor force employed in the jth industry during 1954. The labor coefficient r_{1j} is then defined by:

$$r_{1j} = \frac{L_j}{X_j}$$

where

r_{1j} = the entry in row 1 and column j of the R matrix.

L_j = labor requirements for individual industries, measured by the number of employed persons (including wage earners, proprietors, family workers, etc.)

X_j = corresponding gross domestic outputs, measured in thousand dollars.

Hence, labor coefficients were obtained by first estimating the labor requirements (L_j) for individual industries and then dividing them by the corresponding gross domestic outputs (X_j).[1] The estimated labor coefficients are presented in Table 3.[2]

---

[1] A detailed discussion of estimation procedures by individual sector appears in part III, pp. 52-84.

[2] There is no labor coefficient for sectors 36-37 (households) because domestic service employment has been included in UC 24 (selected services).

TABLE 3

Labor Requirements and Coefficients: Primary Resources Matrix California (1954 Base Year)

UC industry classification	Labor requirements	r_{1j} labor coefficients[a/]
	number of employees	employees per thousand dollars of gross domestic output
1	17,680	.0524814
2	28,970	.0927880
3	58,774	.1710819
4	19,302	.0976185
5	42,101	.1480714
6	95,615	.1959970
7	101,106	.2976840
8	28,575	.2085508
9	33,664	.1857806
10	51,625	.1751318
11	7,835	.0194081
12	19,065	.0185784
13	20,493	.0359130
14	45,507	.0372599
15	59,826	.0346387
16	33,700	.0389472
17	52,474	.0183431
18	246,954	.0617769
19	250,069	.0549650
20	41,395	.0462086
21	348,501	.0755927
22	10,053	.0328412
23	135,611	.0853317
24	394,917	.0890634
25	1,274,789	.1563654
26	750,306	.0734656
27	0	0
28	0	0
29-30	412,332	.0637464
31	163,000	.0411258
32	214,889	.0392186

[a/] Listed elements comprise row 1 of the primary resources matrix, R; that is, elements are r_{1j} of (r_{1j}).

Land and Irrigated Land Coefficients

A great number of land restrictions are effective in reality. The individual restrictions are distinct by virtue of particular soil characteristics, climatic conditions, and geographical location. In the present work, however, only two land restrictions have been recognized: (1) total cropland and (2) irrigable cropland. Accordingly, two sets of land coefficients have been developed: (1) total cropland coefficients and (2) irrigated land coefficients. (Irrigable land is capable of being irrigated; irrigated land is actually under irrigation.)

For the R matrix, then, let r_{2j} denote cropland requirements by industry j and r_{3j} denote irrigated cropland requirements by industry j, where requirements are measured in terms of acres per thousand dollars of gross domestic output. The elements of r_{2j} and r_{3j} then comprise rows 2 and 3 of the R matrix, respectively. These coefficients of the R matrix are exhibited in Table 4.

Cropland requirements are restricted to agricultural sectors. Conversion of cropland to nonagricultural uses can be handled by appropriate reduction of total cropland available in a specific time period. Within the usual period of interest in a particular analysis, the amount of such conversion is likely to be minor, relative to total cropland. At any point in time, the acreage of irrigated crops is restricted by the available acreage of irrigated land. Total acreage of irrigable land represents, therefore, a restriction on irrigated crops only through the limit it sets to the development of irrigated land. The transformation of irrigable land into irrigated land is in itself an investment activity. Estimates of the investment required to convert an acre of irrigable land into irrigated land, by industry of origin of these investment inputs, appears in Table 5; in addition, replacement flows during 1954 and replacement costs per acre also appear.

The measures appearing in Table 5 should be useful in growth models where conversion of irrigable land to irrigated land is part of the growth process.

Water Coefficients

Let water, in acre-feet, used by the jth industry in 1954 = ω_j. Then

$$r_{4j} = \frac{\omega_j}{X_j}$$

where r_{4j} is the entry in row 4, column j, of the R matrix.

TABLE 4

Land Coefficients: Primary Resources Matrix California (1954 Base Year)

UC industry classification[a]	r_{2j} total cropland coefficients[b]	r_{3j} irrigated land coefficients[b]
	acres per thousand dollars	
4	16.398824	8.022379
5	3.094032	3.094032
6	1.812918	1.699145
7	3.109754	2.370517
8	1.971398	1.971398
9	32.166923	12.711903
10	1.306946	1.270339
Average[c]	6.526261	3.666008

[a] UC industries not listed in the table are assumed to require negligible amounts of land.

[b] Elements listed comprise row 2 and row 3, respectively, in the primary resources matrix, R; that is, elements are r_{2j} of (r_{2j}) and r_{3j} of (r_{3j}), respectively.

[c] Weighted average. Weights are shown in Table 2 (aggregate gross technical coefficients).

TABLE 5

Investment and Replacement Costs for Irrigated Land California (1954 Base Year)

UC industry classification	Capital coefficients[a]	Replacement flows, 1954[b]	Replacement costs per acre[c]
	1	2	3
	dollars per acre	thousand dollars	dollars per acre
1-16	[d]		
17			
18	58.929881	15,740	2.233242
19			
20			
21			
22			
23			
24			
25	12.890150	4,308	.611233
26			
27			
28			
29-30	28.991069	7,802	1.106973
31	.032688	11	.001561
32	.672342	228	.032349
33-34			
35			
36-37			
Total	101.516130	28,089	3.985358

[a] Costs per acre to convert irrigable land into irrigated land.

[b] Estimated amount required to replace capital stocks depreciated during 1954.

[c] Obtained by dividing entries in column 2 by total irrigated acres, 1954 (amounting to 7,048,049 acres).

[d] Blanks indicate zero or approximately zero flows.

The entries in r_{4j} are subject to the following limitation. With available data it has been possible to estimate individual water coefficients only for UC 4 through UC 21. Water requirements for other industries consist of requirements for commercial and residential uses mainly (including farm lots). Water requirements for these uses were estimated as a single aggregate only. Since residential use is the major component of this aggregate and since other components are presumably related to the general level of economic activity, it was decided to allocate the aggregate water requirements for UC 1-UC 3 and UC 22-UC 37 to the household sector alone and treat it as an ordinary consumption flow; that is, total water requirements for UC 1-UC 3 and UC 22-UC 37 are assumed to be proportional to household income.1/ Water requirements for all these sectors, then, are summarized in the one coefficient for UC 36-37. (Household income is taken as the row total for UC 36-37 of Table 1, which is net of replacement flows and equals $29,762,108,000 for 1954.)

Estimated water coefficients, measured in acre-feet per thousand dollars of gross domestic output, are presented in Table 6. The listed coefficients refer to 1954 relationships.

In Martin's tables, flow inputs and labor requirements of water production are charged to the government sectors (water utilities) and to industries producing their own water supply; that is, water production is not represented in the matrix as an explicit sector. In the analysis of economic growth, it might be desirable to introduce such a water sector--or sectors--explicitly. Thus, the production of a fairly large increment of water beyond the current level of usage probably involves higher costs per unit since increasing marginal costs can be expected in California water production. If one were to introduce water production into the gross flows matrix and A matrix, it might then be realistic to have more than one water sector. The initial water sector might represent current production, while one or more additional sectors could be set up to reflect higher costs of production per acre-foot as water utilization increased.

1/ Total water requirements for California in 1950 were available in (56). Using this as a base, 1954 requirements were developed by projection from 1950 on the basis of changes in output between those years. Water requirements of UC 1-UC 3 and UC 22-UC 37 were then obtained as a residual after subtracting requirements of the other sectors, UC 4-UC 21.

TABLE 6

Water Coefficients: Primary Resources Matrix California (1954 Base Year)

UC industry classification	r_{4j} water coefficient[a/]
	acre-feet per thousand dollars of gross domestic output
4	23.314184
5	8.411101
6	3.164220
7	7.708929
8	3.226062
9	46.678495
10	3.937195
11	.009977
12	.023125
13	.029276
14	.035742
15	.029916
16	.061052
17	.028370
18	.002319
19	.000956
20	.036614
21	.029293
36-37	.065834[b/]

a/ Listed elements comprise row 4 of the primary resources matrix, R; that is, elements are r_{4j} of (r_{4j}).

b/ Summarizing requirements for sectors UC 1-UC 3 plus UC 22-UC 37; listed in terms of acre-feet per thousand dollars household income.

Levels of Available Primary Resources

In a projection model, levels of Z_{pt} (available primary resources, p = 1, 2, ..., P) should be of relevance. Values of Z_{pt} for 1954 will be noted below; in projections of output for a future year t, development of projected levels of Z_{pt} might be a preliminary step.

The California civilian labor force in 1954 was 5,202,000 persons. Even in times of full employment, there is some fractional unemployment of the labor force. Hence, it is assumed that full employment exists when 97 percent of the labor force is actually employed. This percentage was adopted because the highest observed employment percentage of the United States civilian labor force during the period 1947-1959 was 97.1 percent in 1953 and 96.9 percent in 1952. For all other years in this period, the labor force percentage employed never exceeded 97 percent. Applying this percentage to the 1954 labor force yields a full employment level of 4,965,000 persons, which can thus be taken as the value of $Z_{1,\ 1954}$.

In 1954 the percentage of civilian employment in the nonagricultural sectors was 90.33 percent, so that full civilian employment in the nonagricultural sectors was 4,485,000 persons. (In a given time period, an investigator might wish to treat agricultural and nonagricultural labor as separate categories with a given resource availability for each category.)

Available cropland in 1954 is estimated as 16,810,430 acres, based on U. S. Soil Conservation Service estimates as presented in 1952 by Wohletz and Dolder (75). This figure consists of 16,598,380 acres in Land Utilization Classes I through IV plus 212,050 acres in Land Utilization Classes V through VII. Land in Utilization Classes I through IV is categorized as "suited for cultivation" (with Land Class I the best and Land Class IV the poorest land, as defined in the classification scheme). Land in Utilization Classes V through VII is categorized as "not suited for cultivation." However, in 1952, 212,050 acres in the first three of these classes were in use for crops, fallow, hay, or pasture. Hence, this acreage was included in the total presented above.

The U. S. Census of Agriculture (58) lists 13,229,708 acres as "cropland in farms." The difference between 16.8 million acres and 13.2 million acres can be explained as consisting of cultivable land presently in use in nonfarm grazing and in forest and watershed use.[1]

In estimating irrigable land, it was assumed that the proper base was cropland in farms; that is, it was assumed that land, to be irrigable, had to be in farms as a prior institutional condition. It was then assumed that land in Utilization Subclass IV-e and land in Classes V, VI, and VII were not irrigable. Subclass IV-e is land limited in use by erosion or slope or both. The remaining cropland was defined as irrigable, and this category amounted to 85.4 percent of the total.[2]

This percentage was applied to the base figure (13,229,708 acres) to obtain the corresponding estimate of irrigable land of 11.3 million acres. (This estimate may be contrasted with an alternative figure to be found on page 13 of the California Department of Water Resources, The California Water Plan /Bulletin No. 3, 1957/, which states that, for 1950, "a gross area of about 20 million acres is classified as suitable for irrigated agriculture." This figure differs substantially from the acreage listed above. Part of the difference is explainable by the choice here of cropland in farms as base. In addition, Land Utilization Subclass IV-e was probably defined as irrigable in Bulletin No. 3.

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[1] The following figures in (75) are of relevance:

Land in Utilization Classes	Acres
I through IV	
In crops, fallow, hay, and pasture	10,367,040
Dominantly in grazing use	5,909,260
Dominantly forest and watershed use	322,080
Total acreage	16,598,380
V through VII	
In crops, fallow, hay, and pasture	212,050

If we assume all land in crops, fallow, hay, and pasture (10,579,090 acres) is in farms, then, it would appear that 2.6 million acres are used for grazing on farmland and 3.3 million acres are used for grazing on nonfarmland.

[2] Subclass IV-e contains 2,236,360 acres, while Classes V, VI, and VII contain 212,050 acres interpreted as in-use, in-crop production.

Nevertheless, a fairly large discrepancy remains which must reflect differences in estimate of land suitable for cultivation.)[1]

Water use in 1954 was estimated as approximately 24 million acre-feet, of which 21.2 million acre-feet were used by the agricultural sectors UC 4-UC 10.[2] Thus, agricultural use is estimated as approximately 90 percent of total use.

Table 7 summarizes the levels of available primary resources in 1954 and includes a breakdown of water consumption by UC sectors.

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[1] In terms of total land suitable for cultivation, excluding land in cities and towns and roads and railroads, Wohletz and Dolder (75) list 16.6 million acres, while Bulletin No. 3 lists 20 million acres as both cultivable and irrigable. Turning to figures on land capable of cultivation in a given year, an estimate based on (75) is 13 million acres since Wohletz and Dolder (75) state that Class IV land is suitable for cultivation not more than one year in six. (If Subclass IV-e is excluded, we obtain an estimate of 12.7 million acres of irrigable land.) Bulletin No. 3, page 13, states "an estimated 16,200,000 acres could be irrigated in any one season under ultimate conditions of development."

[2] Based on figures in (17) for 1950 projected forward to 1954.

TABLE 7

Levels of Primary Resources, California, 1954

Primary resource	Category	Level
Labor	Full civilian employment (employees, in thousands)	4,965
Labor	Full employment in nonagricultural sectors (employees, in thousands)	4,485
Land	Total cropland in farms (acres)	13,229,708
Land	Irrigable land (acres)	11,300,000
Land	Irrigated land (acres)	7,048,049
Water	Total consumption (acre-feet, in thousands)	23,640
Water	Agriculture consumption by UC 4-UC 10 (acre-feet, in thousands)	21,224
Water	Consumption by all other sectors (acre-feet, in thousands)	2,416
Water	Consumption by UC 4 (acre-feet, in thousands)	4,610
Water	Consumption by UC 5 (acre-feet, in thousands)	2,392
Water	Consumption by UC 6 (acre-feet, in thousands)	1,544
Water	Consumption by UC 7 (acre-feet, in thousands)	2,618
Water	Consumption by UC 8 (acre-feet, in thousands)	442
Water	Consumption by UC 9 (acre-feet, in thousands)	8,458
Water	Consumption by UC 10 (acre-feet, in thousands)	1,160

C. Capital Coefficients

Definitions and Basic Concepts

Overall capital requirements of any industry consist of (1) capital stocks (stocks of capital goods) required for the expansion of "productive capacity" and (2) inventories. The term, productive capacity, refers to the physical plant of a given sector. It may be measured either by the maximum possible output of that sector or by the value of the capital stock which makes up the productive capacity.

The distinction between capital stocks and inventories is not always clear-cut, and some arbitrariness in definition is unavoidable. "Capital stock coefficients" represent the amount of new capital, by industry of origin, that a producing sector would require for a unit expansion in its capacity output. Inventory coefficients may be defined in similar fashion or may simply be defined as inventories per dollar of output rather than capacity output. The distinction is irrelevant in the construction of the estimated coefficients since 1954 outputs were assumed to be at capacity levels. However, the distinction could be relevant in projections or planning applications. Furthermore, capital stocks are subject to depreciation whereas inventories are not. Two types of inventory coefficients have been distinguished: (1) raw materials and goods-in-process coefficients and (2) finished goods coefficients, or the amount of a given industry's output held in finished form per dollar of output.

Expansion of productive capacity is accomplished through successive expansions of certain capital stocks which constitute immediate restrictions on capacity or through a balanced expansion of all capital stocks. In reality, the first type of expansion is presumably predominant. In this study, however, the balanced expansion is assumed since, in a long-run program of capital accumulation, the aggregated investment activity of the many economic units is likely to resemble more nearly a balanced expansion of industrial capacity. A similar approach was adopted by the U. S. Bureau of the Budget (29) whose study on capital requirements served as our primary source of information on capital coefficients. Many other conceptual problems are involved in the definition, estimation, and use of capital coefficients. These are discussed in some detail in (24), (29), and (34).

In the use of input-output tables developed here for applications involving projections or planning, the value of capital owned by any given industry might be recognized explicitly as a restriction on maximum output. The investigator may treat only the value of capital stocks as the restriction, or he may combine capital stocks and inventories into value of overall capital and treat this as the restriction.[1/]

In the "combined" approach, we can write our matrix of capital coefficients as:

$$K = \begin{bmatrix} k_{11} & \cdots & k_{1n} \\ \vdots & & \vdots \\ k_{n1} & \cdots & k_{nn} \end{bmatrix} = \begin{bmatrix} k^1_{11} & \cdots & k^1_{1n} \\ \vdots & & \vdots \\ k^1_{n1} & \cdots & k^1_{nn} \end{bmatrix} + \begin{bmatrix} k^2_{11} & \cdots & k^2_{1n} \\ \vdots & & \vdots \\ k^2_{n1} & \cdots & k^2_{nn} \end{bmatrix}$$

where k_{ij} is a capital stock coefficient indicating dollars of output from sector i required by sector j per $1.00 expansion in productive capacity by industry j.

Then $\sum_i k_{ij}$ is total capital required for a $1.00 expansion in capacity output of industry j. In similar fashion, k^1_{ij} and k^2_{ij} are defined as capital stock and inventory coefficients, respectively. If only capital stocks restrict productive capacity, then $\sum_i k^1_{ij}$ is the total investment needed to yield a $1.00 expansion in capacity.

Capital restrictions under the combined approach can be written as:

$$Q_t \geq \lambda X_t$$

where

$Q_{t(n \times 1)}$ = a vector of total active capital (stocks plus inventories) by industry of use.

$\lambda_{(n \times n)}$ = a diagonal matrix of total capital coefficients, with $\lambda_{jj} = \sum_i^n k_{ij}$.

$X_{t(n \times 1)}$ = a vector of outputs.

[1/] Each approach appears to involve a number of simplifying assumptions, but a more "realistic" approach might lead to many computational difficulties.

Treating capital stocks as the only restriction, we would write:

$$Q_t^1 \geq \lambda^1 X_t$$

where

Q_t^1 = the value of capital stocks.

λ^1 = a diagonal matrix, given $\lambda_{jj}^1 = \sum_i^n k_{ij}^1$.

In both cases, the composition of capital is assumed to remain constant over time.

Capital stocks which constitute restrictions on productive capacity are formed through the accumulation of net investment. In some cases, however, there exists a time lag between investment and its activation, which may be termed "gestation lag." The capital coefficients defined above represent capital requirements without reference to the timing of investment. In a stationary economy the timing is immaterial, but in a growing economy it is of utmost importance and should be taken into account in any growth model.

Derivation of Capital Stock Coefficients

Capital stock coefficients for agricultural industries are based on several sources. These sources deal directly with California agriculture. Coefficients for nonagricultural industries, on the other hand, are based on information pertaining to the United States as a whole. The major source for the latter industries is a study made by the U. S. Bureau of the Budget on capital requirements for the expansion of industrial capacity (29). This study has been developed with reference to the 1947 interindustry studies of the U. S. Bureau of Labor Statistics (63) and (65). Other important sources are U. S. Internal Revenue Service, Statistics of Income, 1954 (68) and Harvard Economic Research Project, Estimates of the Capital Structure of American Industries, 1947 (28).

Capital stock coefficients developed here are presented in Table 8.

In this report, we develop both capital stock and inventory coefficients and then combine them into an overall capital coefficient. In this very limited sense, then, we have employed the combined approach here.

TABLE 8

Capital Stock Coefficients Matrix
California (1954 Base Year)

UC industry classification	Producer's value									
	UC classification--investing industry									
	1	2	3	4	5	6	7	8	9	10
	dollars invested per dollar expansion in productive capacity a/									
1	b/									
2										
3										
4										
5										
6						.000380				.017116
7										
8								.000015		
9										
10	.005457					.001108	.026036	.026031	.020957	.000257
11										
12										
13										
14										
15										
16						.000932	.040357	.035569	.014292	
17						.000274	.019108	.014489	.006158	
18	.011729	.115068	.094902	.449802	.536253	.144726	.230033	.237419	.442590	.407090
19										
20										
21	.008528	.018594	.006715			.025897	.139322	.047942	.001579	.012770
22						.000005	.000322	.000282	.000115	
23						.000093	.006191	.005522	.000629	
24						.000265	.017575	.014793	.007164	
25	.005624	.029237	.022228	.098388	.117299	.038287	.103178	.093211	.113269	.091895
26						.000189	.011614	.018081	.004643	
27										
28										
29-30	.089625	.356386	.490451	.028457	.073155	.039367	.014874	.007905	.067792	.028464
31	.000039	.000168	.000200	.000187	.000236	.000750	.022846	.034954	.020592	.000175
32	.000806	.003463	.004097	.003846	.004847	.001774	.006447	.007131	.006152	.003605
36-37						.024850	.417523	.707543	.229936	
Total	.121808	.522916	.618593	.580680	.731790	.278897	1.055426	1.250887	.935868	.561372

(Continued on next page.)

TABLE 8--continued.

UC industry classification	Producer's value										
	UC classification--investing industry										
	11	12	13	14	15	16	17	18	19	20	21
	dollars invested per dollar expansion in productive capacity[a]										
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16					.000418	.000075	.000489			.000009	
17							.000432				
18	.055850	.039011	.104803	.117803	.181419	.228398	.221239	.213723	.283914	.306853	.191943
19											
20						.001091	.094613	.000061		.001270	.000821
21	.000319	.001475	.002875	.000501	.003479	.012781	.055658	.002051	.004370	.011593	.002708
22							.000051				
23								.000024			
24								.003159			
25	.012281	.008851	.023538	.025862	.040513	.002387	.081506	.047897	.003078	.003305	.042737
26								.000050			
27											
28											
29-30	.044541	.044897	.079184	.121590	.134872	.084063	.485710	.159138	.112116	.429286	.180144
31	.000036	.000031	.000069	.000086	.000117	.000106	.000303	.000139	.000130	.000243	.000135
32	.000754	.000628	.001403	.001773	.002406	.002193	.006266	.002840	.002692	.005016	.002791
36-37											
Total	.113781	.094893	.211872	.267615	.363224	.331094	.946267	.429082	.406300	.757575	.421279

(Continued on next page.)

TABLE 8--continued.

UC industry classification	Producer's value									
	UC classification--investing industry									
	22	23	24	25	26	27	28	29-30	31	32
	dollars invested per dollar expansion in productive capacity a/									
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16		.005206								
17		.000526								
18	.484205	1.565961	.108008	.744727	.050506			.100868		
19				.009806						
20	.002568	.258087		.010132						
21	.002160	.094121	.065977	.052867	.073013			.001561		
22		.001393								
23	.012755									
24		.047645								
25	.109519	.431045	.038032	.178801	.034133			.022397		
26					.032615					
27										
28										
29-30	.214687	1.387507	.399209	.536150	4.163194			.013902		
31	.000268	.001228	.000198	.000497	.001413			.000046		
32	.005509	.025287	.004076	.010220	.029036			.000926		
36-37										
Total	.831671	3.818006	.615500	1.543200	4.383910			.139700		

a/ Productive capacity refers to the physical plant of a given sector and is measured here by maximum possible annual output of the given sector. Base year output was assumed equal to the capacity level for that year.

b/ Blanks indicate zero or approximately zero stocks.

Derivation of Inventory Coefficients

Two types of inventory coefficients were developed: (1) raw materials and goods-in-process coefficients and (2) finished goods coefficients.

Estimates of raw materials and goods-in-process coefficients for livestock industries are based on relatively little information and are often a result of judgment and somewhat arbitrary assumptions. Estimates of similar coefficients for crop industries are based on a "growth period" concept. Only in the case of manufacturing industries and some other nonagricultural industries are the estimates based on actual inventory data. Allocation of raw materials and goods-in-process inventories to industries of origin was in all cases based on the composition of storable flow inputs to the industry carrying the inventories.

Data on inventories of finished goods were more readily accessible, and corresponding inventory coefficients were more often based on statistical data. Whenever information was available on the actual levels of inventories carried by the various industries in 1954, it was assumed that these represent the "normal" levels of inventories relative to the 1954 gross domestic output of the respective industries.

Inventories of finished goods were ordinarily available in producer's value, and no additional transformations were therefore necessary. Inventories of raw materials and goods in process were first estimated without regard to industry of origin. Allocation among UC industries of origin was then made according to flow inputs from industries whose outputs are storable. To assure that the resulting coefficients are in producer's value, UC 25 was included among the industries to which inventories of raw materials were allocated. No special transformations to producer's value were therefore required.

Table 9 presents inventory coefficients calculated here in terms of (1) raw materials and goods-in-process inventories, appearing in section A of the table; (2) finished goods inventory (that is, inventory of output of industry j on hand in industry j), appearing in section B; and (3) the total inventory coefficient, obtained by adding together the two components listed above, appearing in section C.

The finished goods inventory coefficient is appropriately listed on the main diagonal of matrix (k_{ij}^2).

TABLE 9

Inventories: Raw Materials and Goods-in-Process Coefficients Plus Finished Goods Coefficients California (1954 Base Year)

UC industry classification	Producer's value										
	UC classification--industry carrying the inventory										
	1	2	3	4	5	6	7	8	9	10	11
	dollar value of inventory per dollar value of gross domestic output										
	A. Raw materials and goods in process										
1	a/										
2											
3											
4	.003906	.005891	.003875	.010640						.001554	.032034
5					.001050						
6						.002386				.001256	
7											
8								.000007			
9	.022514		.038049							.001060	.001619
10	.000026		.000924	.009270	.028024	.006953	.019574	.012833	.001203	.005434	
11	.004296	.026638	.016058							.000300	.006672
12										.000578	.000579
13											.000269
14											.000257
15										.001271	.003351
16	.000335	.000340	.000784	.015246	.014738	.005850	.030341	.017535	.000821	.005291	.001641
17	.000211	.000268	.000589	.004636	.002000	.001722	.014366	.007143	.000353	.002823	.000149
18	.000440	.000629	.002820	.018568	.006647	.006156	.033901	.023101	.001757	.008234	.001019
19											
20											
21	.000182	.002646	.000705		.000841	.001917	.003166	.023635		.005621	.005206
22				.000024	.000059	.000033	.000242	.000139	.000001	.000040	.000013
23				.000666	.000812	.000580	.004654	.002722	.000036	.000391	
24				.004500	.001818	.001660	.013213	.007293	.000411	.001454	
25	.003956	.006812	.006925	.017731	.012203	.009662	.026803	.025402	.001329	.009733	.006719
26				.001926	.002188	.001188	.008732	.008914	.000266	.000874	
27	.002299	.000212	.002948							.000108	.009530
28											
29-30				.003018	.003355	.001741	.003956	.003897	.000199	.001305	
31				.008869	.006329	.004202	.017082	.017195	.001172	.003355	
32				.001184	.001366	.000931	.002912	.002752	.000136	.000643	
36-37				.094901	.136781	.105841	.198477	.283727	.012652	.067949	
All industries	.038165	.043436	.073677	.191179	.218211	.150822	.377419	.436295	.020336	.119274	.069058
	B. Finished goods										
Total	.991692	.190162	.838610	.322148	.504109	.000739	.001336	.014866	.009844	.353639	.029210
	C. Total inventory										
All industries	1.029857	.233598	.912287	.513327	.722320	.151561	.378755	.451161	.030180	.472913	.098268

TABLE 9--continued.

UC industry classification	Producer's value									
	UC classification--industry carrying the inventory									
	12	13	14	15	16	17	18	19	20	21
	dollar value of inventory per dollar value of gross domestic output									
	A. Raw materials and goods in process									
1	.067766									.000001
2	.007570	.000002		.000281						
3		.013896								
4				.000362	.000016					
5										.000051
6			.008580	.000819						
7			.011531	.004805	.000029					
8			.000746							
9										
10			.003777	.005148	.000763					.000136
11	.000033	.000010	.000523	.009828	.000378				.000031	
12	.006145	.000097	.000954	.002825	.003214					.000106
13	.000119	.002797	.000060	.001675	.000103					.000020
14	.000267	.000052	.001088	.001192	.000150					
15	.000678	.001222	.005859	.036384	.002685		.000001		.000001	.000085
16	.000990	.000159	.001661	.012559	.048405	.002028	.003809	.004544	.000952	.006330
17	.000119	.000066	.000077	.000498	.003271	.043935	.000677	.002584	.003504	.001283
18	.001261	.000535	.006214	.003093	.002578	.001820	.077957	.083140	.002304	.007140
19							.000188	.061736		
20					.002208	.000069	.044098	.055913	.065766	.002957
21	.000808	.000788	.004633	.008405	.006408	.001120	.017556	.037322	.002625	.063807
22				.000024	.001854	.000081	.000075		.004355	.001291
23										
24										
25	.0003216	.000996	.001860	.007929	.005538	.004766	.009899	.014471	.007966	.009350
26										
27	.005463				.006839		.000285	.009956	.003166	
28	.000197			.011548	.001736	.000021	.000626	.003818	.013948	.000792
29-30										
31										
32										
36-37										
All industries	.094632	.020620	.047563	.107375	.086175	.053840	.155171	.273484	.104618	.093349
	B. Finished goods									
Total	.035016	.023484	.180691	.090829	.058973	.062211	.054095	.012059	.034169	.051863
	C. Total inventory									
All industries	.129648	.044104	.228254	.198204	.145148	.116051	.209266	.285543	.138787	.145212

(Continued on next page.)

TABLE 9--continued.

UC industry classification	Producer's value									
	UC classification--industry carrying the inventory									
	22	23	24	25	26	27	28	29-30	31	32
	dollar value of inventory per dollar value of gross domestic output									
	A. Raw materials and goods in process									
1				.002493						
2				.002946						
3										
4				.001459						
5				.002116						
6				.004710						
7				.000925						
8				.000384						
9										
10				.001516						
11		.000003	.000425	.004807	.000008					
12		.000352	.003403	.017150	.000126					
13		.000213	.002614	.008674	.000045					
14		.000134	.001709	.005317	.000030					
15		.000364	.007644	.048221	.000087			.000005		
16		.000650	.001460	.015392	.000368			.001781		
17		.040969	.000916	.022061	.000976			.001741		
18		.008661	.011047	.119298	.000103			.014608		
19			.000029	.000013						
20		.001155	.000012	.007175	.000033			.004803		
21		.006200	.005299	.137585	.004830			.014663		
22				.000260				.001108		
23										
24										
25		.017004	.009470	.000504	.002424			.013505		
26										
27		.000435		.003189				.000093		
28		.003766	.000002	.000117	.000005			.000003		
29-30										
31										
32										
36-37										
All industries		.079906	.044030	.406312	.009035			.052310		
	B. Finished goods									
Total	.081261									
	C. Total inventory									
All industries	.081261	.079906	.044030	.406312	.009035			.052310		

a/ Blanks indicate zero or approximately zero inventories.

Combined Capital Coefficients and Investment Matrix

Combined Capital Coefficients.--Combined capital coefficients are presented in Table 10. Every element in the table is a sum of corresponding capital stock and inventory coefficients. The diagonal elements of the table include "finished goods" inventory coefficients in addition to the capital and "raw materials and goods in process" coefficients. Table 10, then, exhibits the estimated elements of the K matrix defined above.[1/]

The Investment Matrix.--If we are given the total value of investment in industry j in year t, we can form the vector of investments:

$$I^o_{t(n \times 1)} = (i^o_{jt})$$

where i^o_{jt} is the total of new investment in industry j, yielding an expansion of productive capacity in j.

Given the capital coefficient matrix of Table 10, we can form an investment matrix W. An element of W, w_{ij}, is defined as the value of output of the ith industry required by the jth industry per unit of investment in j. Symbolically:

$$w_{ij} = \frac{k_{ij}}{\sum_i k_{ij}}$$

Given I^o_t and assuming W is stable over time, we can derive a vector of investment goods by industry of origin. Thus, let I_t = the vector of investment goods produced by the industries of the economy:

$$I_{t(n \times 1)} = (i_{jt})$$

[1/] K has been presented as an n x n matrix rather than as an m x m matrix because this generalized form allows capital to originate in or be required by exogenous sectors. For the tables presented here, government and household expenditures on durables are regarded as consumption so that UC 27, 28, 31, 32, and 36-37 all have column entries equal to zero.

With respect to row entries, expansion capital coefficients originating in the household sector have been constructed in agricultural industries involving perennial crops. This is particularly true for UC 7 and UC 8 where the established orchards are the main capital stock. The origin of these stocks was traced and allocated to industries supplying flow inputs to the utilizing industries, and, as a consequence, the household sector became a source of capital stocks (for further discussion of this point, see page 61).

TABLE 10

Combined Capital Coefficient Matrix
California (1954 Base Year)

UC industry classification	UC classification--investing industry										
	1	2	3	4	5	6	7	8	9	10	11
	dollars invested per dollar expansion in productive capacity[a/]										
1	.991692	b/									
2		.190162									
3			.838610								
4	.003906	.005891	.003875	.332788						.001554	.032034
5					.505159						
6						.003505				.018372	
7							.001336				
8								.014888			
9	.022514		.038049						.009844	.001060	.001619
10	.005483		.000924	.009270	.028024	.008061	.045610	.038864	.022160	.359330	
11	.004296	.026638	.016058							.000300	.035882
12										.000578	.000579
13											.000269
14											.000257
15										.001271	.003351
16	.000335	.000340	.000784	.015246	.014738	.006782	.070698	.053104	.015113	.005291	.001641
17	.000211	.000268	.000589	.004636	.002000	.001996	.033474	.021632	.006511	.002823	.000149
18	.012169	.115697	.097722	.468370	.542900	.150882	.263934	.260520	.444347	.415324	.056869
19											
20											
21	.008710	.021240	.007420		.000841	.027814	.142488	.071577	.001579	.018391	.005525
22				.000024	.000059	.000038	.000564	.000421	.000116	.000040	.000013
23				.000666	.000812	.000673	.010845	.008244	.000665	.000391	
24				.004500	.001818	.001925	.030788	.022086	.007575	.001454	
25	.009580	.036049	.029153	.116119	.129502	.047949	.129981	.118613	.114598	.101628	.019000
26				.001926	.002188	.001377	.020346	.026995	.004909	.000874	
27	.002299	.000212	.002948							.000108	.009530
28											
29-30	.089625	.356386	.490451	.031475	.076510	.041108	.018830	.011802	.067991	.029769	.044541
31	.000039	.000168	.000200	.009056	.006565	.004952	.039928	.052149	.021764	.003530	.000036
32	.000806	.003463	.004097	.005030	.006213	.002705	.009359	.009883	.006288	.004248	.000754
36-37				.094901	.136781	.130691	.616000	.991270	.242588	.067949	
Total	1.151665	.756514	1.530880	1.094007	1.454110	.430458	1.434181	1.702048	.966048	1.034285	.212049

(Continued on next page.)

TABLE 10--continued.

UC industry classification	UC classification--investing industry										
	12	13	14	15	16	17	18	19	20	21	22
	dollars invested per dollar expansion in productive capacity[a]										
1	.067766									.000001	
2	.007570	.000002		.000281							
3		.013896									
4				.000362	.000016						
5										.000051	
6			.008580	.000819							
7			.011531	.004805	.000029						
8			.000746								
9											
10			.003777	.005148	.000763					.000136	
11	.000033	.000010	.000523	.009828	.000378				.000031		
12	.041161	.000097	.000954	.002825	.003214					.000106	
13	.000119	.026281	.000060	.001675	.000103					.000020	
14	.000267	.000052	.181779	.001192	.000150						
15	.000678	.001222	.005859	.127213	.002685		.000001		.000001	.000085	
16	.000990	.000159	.001661	.012977	.107453	.002517	.003809	.004544	.000961	.006330	
17	.000119	.000066	.000077	.000498	.003271	.106578	.000677	.002584	.003504	.001283	
18	.040272	.105338	.124017	.184512	.230976	.223059	.345775	.367054	.309157	.199083	.484205
19							.000188	.073795			
20					.003299	.094682	.044159	.055913	.101205	.003778	.002568
21	.002283	.003663	.005134	.011884	.019189	.056778	.019607	.041692	.014218	.118378	.002160
22				.000024	.001854	.000132	.000075		.004355	.001291	.081261
23							.000024				.012755
24							.003159				
25	.012067	.024534	.027722	.048442	.007925	.086272	.057796	.017549	.011271	.052087	.109519
26							.000050				
27	.005463				.006839		.000285	.009956	.003166		
28	.000197			.011548	.001736	.000021	.000626	.003818	.013948	.000792	
29-30	.044897	.079184	.121590	.134872	.084063	.485710	.159138	.112116	.429286	.180144	.214687
31	.000031	.000069	.000086	.000117	.000106	.000303	.000139	.000130	.000243	.000135	.000268
32	.000628	.001403	.001773	.002406	.002193	.006266	.002840	.002692	.005016	.002791	.005509
36-37											
Total	.224541	.255976	.495869	.561428	.476242	1.062318	.638348	.691843	.896362	.566491	.912932

(Continued on next page.)

TABLE 10--continued.

UC industry classification	UC classification--investing industry								
	23	24	25	26	27	28	29-30	31	32
	dollars invested per dollar expansion in productive capacity a/								
1			.002493						
2			.002946						
3									
4			.001459						
5			.002116						
6			.004710						
7			.000925						
8			.000384						
9									
10			.001516						
11	.000003	.000425	.004807	.000008					
12	.000352	.003403	.017150	.000126					
13	.000213	.002614	.008674	.000045					
14	.000134	.001709	.005317	.000030					
15	.000364	.007644	.048221	.000087			.000005		
16	.005856	.001460	.015392	.000368			.001781		
17	.041495	.000916	.022061	.000976			.001741		
18	1.574622	.119055	.864025	.050609			.115476		
19		.000029	.009819						
20	.259242	.000012	.017307	.000033			.004803		
21	.100321	.071276	.190452	.077843			.016224		
22	.001393		.000260				.001108		
23									
24	.047645								
25	.448049	.047502	.179305	.036557			.035902		
26				.032615					
27	.000435		.003189				.000093		
28	.003766	.000002	.000117	.000005			.000003		
29-30	1.387507	.399209	.536150	4.163194			.013902		
31	.001228	.000198	.000497	.001413			.000046		
32	.025287	.004076	.010220	.029036			.000926		
36-37									
Total	3.897912	.659530	1.949512	4.392945			.192010		

a/ Productive capacity refers to the physical plant of a given sector and is measured here by maximum possible annual output of the given sector. Dollars invested includes investment in capital stock and inventories.

b/ Blanks indicate zero or approximately zero stocks.

where i_{jt} is the total of investment goods produced by industry j for use by all the sectors of the economy.

Then, it can be seen that:

$$I_t = WI_t^o.$$

Hence, the development of the capital coefficient matrix can be extended to the derivation of the investment matrix, which in turn can be used to estimate investment goods flows by industry of origin on the basis of total investment in industries of use (destination).

An investment matrix is developed here from Table 10. As an initial step, all capital coefficients originating in the household sector[1/] were distributed among other industries according to their flow inputs to the investing industry. (This was done because some anticipated applications of the W matrix involved no direct inputs from the household sector.)

The changes involved affect only UC 4 through UC 10. The modified capital coefficients for these sectors appear in Table 11.

The investment matrix is then derived using the transformation noted previously. This matrix appears as Table 12.

D. Replacement Flows

The replacement flow, D_{ij}, is the value of output of the ith industry purchased by the jth industry for the purpose of replacing its productive capacity; that is, it is the amount of investment goods produced by industry i that is needed by industry j to replace capital goods used up in the production process. It follows that outputs of all investment goods industries are used for replacement purposes. These include outputs of the "trade and transportation" sector, as well as "governments," since D_{ij} is expressed in producer's value. One would expect, therefore, that all industries of origin listed in the capital coefficients matrix would be represented in the replacement matrix. This, however, is not the case since the present definition of capital goods differs in some respects from Martin's definitions. Thus, for instance, inputs purchased

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[1/] This is discussed in greater detail in part III; see pages 60 and 61.

TABLE 11

Modified Capital Coefficients
California (1954 Base Year)

UC industry classification	UC classification--investing industry[a]						
	4	5	6	7	8	9	10
	dollars invested per dollar expansion in productive capacity[b]						
1	[c]						
2							
3							
4	.343276						.003611
5		.506923					
6			.010230				.020035
7				.001336			
8					.014935		
9						.009844	.002463
10	.018407	.075097	.027658	.110915	.122242	.059697	.366524
11							.000697
12							.001343
13							
14							
15							.002954
16	.030274	.039494	.023270	.171926	.167033	.040712	.012296
17	.009206	.005359	.006850	.081404	.068041	.017538	.006560
18	.486672	.554065	.168233	.377041	.410611	.499156	.426225
19							
20							
21		.002254	.037130	.172035	.225139	.004258	.025833
22	.000048	.000158	.000131	.001371	.001324	.000313	.000093
23	.001322	.002176	.002308	.026373	.025932	.001792	.000909
24	.008936	.004872	.006603	.074871	.069470	.020406	.003379
25	.133596	.150000	.075182	.219404	.283657	.156065	.114513
26	.003824	.005863	.004726	.049478	.084911	.013224	.002031
27							.000251
28							
29-30	.034450	.082146	.046015	.032029	.037122	.074184	.031497
31	.017798	.017196	.016795	.096920	.163867	.058320	.007972
32	.006197	.008508	.005329	.019076	.027762	.010539	.005099
Total	1.094006	1.454111	.430460	1.434179	1.702046	.966048	1.034285

a/ Only sectors UC 4-UC 10 are modified, by way of redistribution of row 36-37 entries appearing in Table 10.

b/ Productive capacity refers to the physical plant of a given sector and is measured here by maximum possible annual output of the given sector. Dollars invested includes investment in capital stock and inventories.

c/ Blanks indicate zero or approximately zero stocks.

TABLE 12

Investment Coefficients: **W Matrix**
California (1954 Base Year)

UC industry classification	UC classification--investing industry									
	1	2	3	4	5	6	7	8	9	10
	investment by sector source divided by total investment[a]									
1	.861095	[b]								
2		.251366								
3			.547796							
4	.003392	.007787	.002531	.313779						.003491
5					.348614					
6						.023765				.019371
7							.000932			
8								.008775		
9	.019549		.024854						.010190	.002381
10	.004761		.000604	.016825	.051645	.064252	.077337	.071821	.061795	.354374
11	.003730	.035212	.010489							.000674
12										.001298
13										
14										
15										.002856
16	.000291	.000449	.000512	.027673	.027160	.054058	.119878	.098137	.042143	.011888
17	.000183	.000354	.000385	.008415	.003685	.015913	.056760	.039976	.018154	.006342
18	.010566	.152934	.063834	.444853	.381033	.390821	.262896	.241245	.516699	.412097
19										
20										
21	.007563	.028076	.004847		.001550	.086257	.119954	.132276	.004408	.024977
22				.000044	.000109	.000304	.000956	.000778	.000324	.000090
23				.001208	.001496	.005362	.018389	.015236	.001855	.000879
24				.008168	.003351	.015339	.052205	.040816	.021123	.003267
25	.008318	.047651	.019043	.122116	.103156	.174656	.152981	.166655	.161550	.110717
26				.003495	.004032	.010979	.034499	.049888	.013689	.001964
27	.001996	.000280	.001926							.000243
28										
29-30	.077822	.471091	.320372	.031490	.056492	.106898	.022333	.021810	.076791	.030453
31	.000034	.000222	.000131	.016269	.011826	.039016	.067579	.096276	.060370	.007708
32	.000700	.004578	.002676	.005665	.005851	.012380	.013301	.016311	.010909	.004930
Total	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

(Continued on next page.)

TABLE 12--continued.

UC industry classification	UC classification--investing industry									
	11	12	13	14	15	16	17	18	19	20
	investment by sector source divided by total investment[a]									
1		.301798								
2		.033713	.000008		.000501					
3			.054286							
4	.151069				.000645	.000034				
5										
6				.017303	.001459					
7				.023254	.008559	.000061				
8				.001504						
9	.007635									
10				.007617	.009169	.001602				
11	.169216	.000147	.000039	.001055	.017505	.000794				.000035
12	.002731	.183312	.000379	.001924	.005032	.006749				
13	.001269	.000530	.102670	.000121	.002983	.000216				
14	.001212	.001189	.000203	.366586	.002123	.000315				
15	.015803	.003019	.004774	.011816	.226588	.005638		.000002		.000001
16	.007739	.004409	.000621	.003350	.023114	.225627	.002369	.005967	.006568	.001072
17	.000703	.000530	.000257	.000155	.000887	.006868	.100326	.001061	.003735	.003909
18	.268187	.179353	.411515	.250100	.328648	.484996	.209974	.541671	.530545	.344902
19								.000295	.106664	
20						.006927	.089128	.069177	.080817	.112906
21	.026055	.010167	.014310	.010354	.021167	.040293	.053447	.030715	.060262	.015862
22	.000061				.000043	.003893	.000124	.000117		.004859
23								.000038		
24								.004949		
25	.089602	.053741	.095845	.055906	.086284	.016641	.081211	.090540	.025366	.012574
26								.000078		
27	.044942	.024330				.014360		.000446	.014391	.003532
28		.000877			.020569	.003645	.000020	.000981	.005519	.015561
29-30	.210050	.199950	.309342	.245206	.240230	.176513	.457218	.249296	.162054	.478920
31	.000170	.000138	.000270	.000173	.000208	.000223	.000285	.000218	.000188	.000271
32	.003556	.002797	.005481	.003576	.004286	.004605	.005898	.004449	.003891	.005596
Total	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

(Continued on next page.)

TABLE 12--continued.

UC industry classification	UC classification--investing industry										
	21	22	23	24	25	26	27	28	29-30	31	32
	investment by sector source divided by total investment[a/]										
1	.000002				.001279						
2					.001511						
3											
4					.000748						
5	.000090				.001085						
6					.002416						
7					.000474						
8					.000197						
9											
10	.000240				.000778						
11			.000001	.000644	.002466	.000002					
12	.000187		.000090	.005160	.008797	.000029					
13	.000035		.000055	.003963	.004449	.000010					
14			.000034	.002591	.002727	.000007					
15	.000150		.000093	.011590	.024735	.000020			.000026		
16	.011174		.001502	.002214	.007895	.000084			.009276		
17	.002265		.010645	.001389	.011316	.000222			.009067		
18	.351432	.530385	.403967	.180515	.443202	.011521			.601405		
19				.000044	.005037						
20	.006669	.002813	.066508	.000018	.008878	.000008			.025014		
21	.208967	.002366	.025737	.108071	.097692	.017720			.084496		
22	.002279	.089011	.000357		.000133				.005771		
23		.013971									
24			.012223								
25	.091947	.119964	.114946	.072024	.091974	.008322			.186980		
26						.007424					
27			.000112		.001636				.000484		
28	.001398		.000966	.000003	.000060	.000001			.000016		
29-30	.318000	.235162	.355962	.605294	.275018	.947698			.072402		
31	.000238	.000294	.000315	.000300	.000255	.000322			.000240		
32	.004927	.006034	.006487	.006180	.005242	.006610			.004823		
Total	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

a/ Investment in industry j of capital goods and inventories purchased from industry i per unit of investment in industry j.

b/ Blanks indicate zero or approximately zero stocks.

by UC 7 for the purpose of establishing new orchards are not distinguished by Martin from other flow inputs. In general, only durable producer's goods were allocated by Martin to UC 35, the gross private capital formation sector. The difference in definitions does not cause any difficulties in our analysis since all other replacement flows are already included in the current transactions flow table. Replacement flows are, therefore, derived only for those industries whose outputs were distributed by Martin to UC 35. These are presented in Table 13, and the replacement flows are incorporated into Table 1.

As indicated in section A of part II, a given row sum of replacement flows was treated as an offset to the corresponding row element in the column vector of flows to UC 35. Hence, for a particular row i, the sum of the offset to UC 35 (appearing in Table 13) and the element appearing in UC 35 in Table 1 could be expected to yield the corresponding row entry for UC 35 in Table I-I of Martin and Carter (36). This is generally the case. However, a number of modifications in UC 35 entries were developed here and are noted in part III, section D. A consequence is that for UC 18 and UC 21 there is some deviation from the Martin and Carter figure. Other adjustments, however, established equivalence between row and column totals.

TABLE 13

Replacement Flows
California (1954 Base Year)

UC industry classification	UC classification--purchasing industry 1	2	3	4	5	6	7	8	9	10	11
	thousand dollars										
1-16	a/										
17											
18	236	2,406	1,828	6,915	17,091	3,398	4,418	1,366	6,998	3,988	1,172
19											
20											
21	112	237	76			628	2,505			205	4
22											
23											
24											
25	147	770	536	1,893	4,679	1,594	2,385	374	1,916	1,306	303
26											
27											
28											
29-30	1,452	6,591	5,536	216	797	365	82		447	217	601
31		3	3	4	10	3	5	1	4	3	1
32	15	71	55	81	203	70	102	16	84	57	17
33, 34, 35, and 36-37											
Total	1,962	10,078	8,034	9,110	22,779	6,059	9,496	1,757	9,450	5,776	2,098

(Continued on next page.)

TABLE 13--continued.

UC industry classification	UC classification--purchasing industry										
	12	13	14	15	16	17	18	19	20	21	22
	thousand dollars										
1-16											
17						21					
18	2,198	3,136	7,863	15,776	10,450	36,390	33,521	76,985	17,983	44,658	8,890
19											
20											
21	54	47	21	277	877	12,374	3,291	1,092	1,026	641	66
22											
23											
24											
25	584	813	2,024	4,149	150	15,816	10,138	1,073	261	11,882	2,465
26							37				
27											
28											
29-30	1,695	1,359	5,262	7,856	2,747	50,806	17,021	20,738	18,370	28,239	2,583
31	2	2	6	11	6	47	27	43	14	34	6
32	36	45	121	232	131	965	549	879	296	689	119
33, 34, 35, and 36-37											
Total	4,569	5,403	15,297	28,301	14,361	116,420	64,583	100,809	37,950	86,143	14,130

(Continued on next page.)

TABLE 13--continued.

UC industry classification	UC classification--purchasing industry										
	23	24	25	26	27	28	29-30	31	32	33, 34, 35, and 36-37	Total (offset to UC 35)
	thousand dollars										
1-16											
17	3										24
18	59,364	52,481	250,631	31,992			55,474				757,609
19			10,000								10,000
20											
21	4,536	24,563	8,686	26,710			2,146				90,173
22											
23											
24											
25	15,821	23,981	74,074	22,958			15,397				217,488
26				17,041							17,078
27											
28											
29-30	44,663	118,434	91,504	1,360,708			5,000				1,793,290
31	50	86	180	434			34				1,019
32	1,018	1,769	3,709	8,919			709				20,957
33, 34, 35, and 36-37											
Total	125,454	221,314	438,784	1,468,761			78,761				2,907,638

a/ Blanks indicate zero or approximately zero flows.

III. DETAILED DESCRIPTION OF DERIVATION OF MATRICES

In this part of the report, we present a detailed description of the derivation of the matrices appearing in part II. This description follows the organization of part II, with particular sections (in order) devoted to primary resources, capital stock coefficients, inventory coefficients, and replacement flows, respectively.

In each section, the derivation of coefficients is presented for each UC sector in turn.

A. Derivation of Primary Resources Coefficients

Labor Coefficients

Labor coefficients were obtained by estimating the labor requirements (L_j) for individual industries and then dividing them by the corresponding gross domestic outputs (X_j).

UC 1-UC 10.--Labor requirements per unit level of various agricultural activities (measured in acres, heads of livestock, etc.) were estimated by Shultis and Bailey (40) for the year of 1955. When, however, total labor requirement for UC 1-UC 10 was obtained from these coefficients and the corresponding 1954 levels of the activities, it was found to be less than the actual civilian employment in "agriculture, forestry, and fishing" reported in (12).[1] Estimates based on Shultis and Bailey coefficients were therefore inflated to assure equality of the computed 1954 total labor requirements and reported employment. Labor requirements for individual activities were then aggregated by UC industries. Employment data available in (12) included, however, some agricultural labor force involved in construction activities which, by definition, belongs to the construction sector. Final estimates of total labor requirement for the individual industries were therefore obtained after subtracting the estimated noncontract construction from the initial estimates of total labor requirements. The derivation of noncontract construction workers is explained under UC 29-30.

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[1] Levels of the various agricultural activities were obtained from (4), (6), (41), and (72).

UC 11-UC 21.--Employment figures for the manufacturing industries were available in (62). Since UC 17 has been defined to include "crude petroleum and natural gas" in addition to "petroleum products" reported in (62), estimates of civilian employment in crude petroleum and natural gas were added to the figures in (62). The derivation of these estimates is explained below under UC 22.

Since (62) classifies fluid milk pasteurization (UC 13) under "trade," it was necessary to increase total civilian employment in manufacturing industries and reduce it accordingly in trade. This was accomplished using employment estimates for UC 13, available in (11).

The total employment figure for UC 11-UC 21 thus obtained from (62) amounted to 1,055,945 employees. This total is somewhat lower than civilian employment in manufacturing industries (1,129,915 employees), reported in (12). Labor requirements in individual manufacturing industries were therefore adjusted up so that their totals conformed to the latter estimates.

Noncontract construction workers were subtracted from resulting estimates of labor requirements since they belong, by definition, to the construction sector.

UC 22.--Total civilian employment in "mineral extraction" was available in (12). This figure, however, included employment in both "mining" and crude petroleum and natural gas which, by definition, belong to two different UC industries. The overall employment figure was therefore allocated among its two components according to wage and salary employment. Employment in crude petroleum and natural gas was then transferred to UC 17. The estimated employment in mining, with noncontract construction workers netted out, was regarded as total civilian employment in UC 22.

UC 23.--Total civilian employment in "transportation, communication, and utilities," available in (12), was allocated to "transportation" and "communication and utilities" according to "wage and salary" workers, available in (12). To the latter was added the estimate of civilian employment in public utilities (excluding water supply) to get civilian employment in UC 23. The derivation of the employment estimate for public utilities is explained under UC 31. Noncontract construction employment again was subtracted.

UC 24.--Civilian employment in "finance, insurance, and real estate" and in "service," available in (12), was allocated to UC 24 and UC 26 according to wage and salary workers, available in (12). Noncontract construction employment again was subtracted.

UC 25.--To civilian employment in trade, available in (12), was added the estimate of civilian employment in transportation whose derivation is explained under UC 23. Noncontract construction employment was then subtracted.

UC 26.--Part of the civilian employment in UC 26 was obtained as explained under UC 24. To this was added the estimate of civilian employment in public education, health, and hospitals. The derivation of the latter estimates is explained under UC 31. Noncontract construction employment was then subtracted.

UC 27 and UC 28.--No labor is required for these industries.

UC 29-30.--UC 29 and UC 30 were aggregated into a single industry. Civilian employment data were available in (12) for contract construction alone. To estimate noncontract construction employment, the crude assumption was made that the ratio of contract construction employment to noncontract construction employment is equal to the ratio of new construction to maintenance construction outputs. Since employment in noncontract construction is usually reported with employment corresponding to the respective nonconstruction industries, it was necessary to estimate this employment for individual industries and then transfer it to the construction industry. According to the earlier assumption, these estimates were obtained on the basis of maintenance construction inputs to the various industries available in (35).

UC 31 and UC 32.--Total civilian employment (annual average) in government was available in (12). The distribution of employment between UC 31 and UC 32 and within UC 31 for the month of October was available in (55). Using this distribution, annual civilian employment in government was allocated to UC 23 (public utilities except water), UC 26 (public education, health, and hospitals), UC 31, and UC 32. Noncontract construction employment again was subtracted.

Land and Irrigated Land Coefficients

Total acreage of specified crops harvested, acreage of specified crops harvested from irrigated land, and acreage of irrigated land were available in (8) and (58). For irrigated crops, the acreage harvested was greater than the one actually used in the crop rotation since some double-cropping was practiced. It followed that UC industries comprising crops which were involved in double-cropping used less of the irrigated land than was suggested by the harvested acreage. To allow for this, an intensity factor was developed, such that division of the acreage harvested from irrigated land by this factor yielded an estimate of the acreage of irrigated land actually used. Only two values of the intensity factor were considered; the first was associated with crops where double-cropping was not practiced and was always equal to unity, and the second was associated with crops for which double-cropping was common and was always greater than unity. An estimate of the latter value was obtained by dividing the acreage of intensive crops harvested from irrigated land by the acreage of irrigated land available to them.

Total cropland utilization in 1954 for the various UC industries was obtained by first summing up nonirrigated cropland and adjusted irrigated cropland for individual crops and then aggregating by UC industries. Irrigated land utilization values were obtained by applying a similar procedure to the adjusted irrigated cropland figures. Respective land coefficients were derived by dividing the utilization values by the appropriate gross domestic outputs.

Water Coefficients

UC 4-UC 10.--Water requirements of UC 4-UC 10 are defined as the amount of water delivered to the utilizing sector. Estimated per-acre requirements of applied water for consumptive use of various irrigated crops by hydrographic units are available in (17). Acreage of irrigated crops in 1954 by counties is available in (58). In order to combine the information from the two sources, county-applied water coefficients for individual crops have been developed as weighted averages of the corresponding hydrographic units coefficients; 1950 acreages of irrigated crops in the hydrographic units, available in (17), served as weights in forming these averages. The county-applied water coefficients thus obtained were then multiplied by 1954 acreages of the various crops in each county to obtain the 1954 county-applied water requirements by crops. Applied water requirements for consumptive use are not identical, however, with the delivery requirements since some water is ordinarily lost in irrigation and is not available to the plants. Estimates of the efficiency factor by counties are available in (17). Dividing the county-applied water requirements by the county efficiency factor yielded the county 1954 delivery requirements. State delivery requirements by crops obtained from the county requirement were aggregated by UC industries to give 1954 state delivery requirements by UC industries. The corresponding water coefficients were then obtained as ratios of the 1954 state water requirement of individual UC industries to their respective gross domestic outputs.

UC 11-UC 21.--Freshwater intake by industries for the United States and for California in 1954 is available in (61). However, data on water intake in California are aggregated over UC 11-UC 15 and UC 18-UC 19. Disaggregation was accomplished as follows. Total United States water requirement was first aggregated by UC industries. Preliminary estimates of California water intake by UC industries were then obtained from the United States figures on the assumption that water intake in each industry is proportional to the value added by the industry. The preliminary estimates thus obtained served as an allocation base for disaggregating the water requirements to the individual industries UC 11-UC 15 and UC 18-UC 19. Water coefficients were derived as ratios of freshwater requirements of the individual industries to the gross domestic outputs of the various industries.

UC 1-UC 3 and UC 22-UC 37.--As indicated in part II, total water requirements for UC industries 1-3 and 22-37 are assumed to be proportional to household income. Water requirements for these sectors are summarized in the coefficient for UC 36-37.

B. Derivation of Capital Stock Coefficients

Agricultural Sectors

UC 1.--Values of initial investment in cattle and calves, hogs, and sheep and lambs enterprises (in synthesized farm units) for the period 1951-52 were available in (2). In all cases, the investment figures were relevant to farm conditions rather than range conditions. These figures were chosen since expansion in livestock enterprises was envisaged to take place primarily under farm conditions. Values of initial investment in the various capital goods were aggregated by UC industries of origin. Capital coefficients for each of the enterprises were then calculated as ratios of capital requirements to values of production in the synthesized enterprises in 1951, available in (2). Preliminary estimates of capital coefficients for UC 1 were developed as weighted averages of the individual enterprise coefficients using the corresponding gross domestic outputs, available in (35), as weights. Two adjustments had to be made, however, before the final capital coefficients were obtained. The first adjustment involved the coefficient of capital goods originating in the construction sector. The second adjustment followed from the fact that the preliminary estimates were in purchaser's value.

The first adjustment was necessary because farm improvements and nonresidential building used by the various agricultural industries are partly owned by the rental sector.[1] Accordingly, agricultural industries are charged with rent payments on current account transactions. To allow for this, it was necessary to reduce the investment requirements of agricultural industries for output of the construction industry. It was therefore assumed that United States inputs of maintenance construction directly to agricultural industries, as compared to total nonresidential farm maintenance construction, reflect the proportion of investment in farm nonresidential construction made directly by the agricultural industries. Related data for 1947 were available in (37), and the proportion of investment in farm nonresidential construction made directly by agricultural industries was calculated to be .728598.[2] The preliminary estimates of the construction capital coefficient were, therefore, multiplied by .728598.

As noted above, the second adjustment here was necessary because capital coefficients were measured in purchaser's value.

In order to transform the coefficients to producer's value, it was assumed that trade and transportation margins bore the same relation to the overall capital coefficient in producer's value (excluding coefficients originating in UC 25, UC 29-30, UC 31, and UC 32) as they did in UC 35 (gross private capital formation). Trade and transportation margins were accordingly subtracted from all capital coefficients, excluding those originating in UC 25, UC 29-30, UC 31, and UC 32. The sum of the trade and transportation margins was regarded as the

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[1] In the 1947 U. S. Bureau of Labor Statistics studies (63) and (64), Emergency Model (EM) 183 was "real estate and rentals"; this appears as a subsector of UC 26. Cf. (36), p. 23. Rent payments are outputs of the "rental sector."

[2] The calculations involved were:

Maintenance construction inputs

In agricultural industries	$233,880,000
To farm nonresidential rental sector	87,120,000
Total to agriculture	$321,000,000

Hence, the total ratio obtained is:

$$\frac{233,880}{321,000} = .728598.$$

coefficient of capital originating in UC 25.[1] Column entries for UC 35 indicate that there were output flows from UC 31 and UC 32 (state and federal government) into gross private capital formation during 1954. These flows represent taxes on durable producer's goods and construction activities and should be taken into account in transforming capital coefficients to producer's value. Again, it was assumed that these tax margins constituted the same proportion of total investment in individual industries as in UC 35. All capital coefficients were adjusted down accordingly, and estimates of capital coefficients originating in UC 31 and UC 32 were thus generated.[2]

UC 2.--The poultry and eggs sector contained the following subsectors: eggs and laying chickens, broilers or fryers, and turkeys (hereafter generally referred to as eggs and chickens, broilers, and turkeys). Capital coefficients in purchaser's value were first developed for egg and chicken, broiler, and turkey production separately. These were then aggregated into weighted averages for UC 2 using the gross domestic outputs of the individual activities, available in (35), as weights.

Data on investment requirements per unit output in egg and chicken production for the years 1948 and 1959 were available in (42) and (39), respectively. It was assumed that the total capital coefficient in 1954 was about equal to the average of its 1948 and 1959 values, while the composition of capital was as in 1948.

Data on investment in broiler production were based on one county, San Luis Obispo alone, and reflected conditions in 1956. These are given in (28). In judging the reliability of such scanty data, one should recall, however, that broiler production methods are fairly uniform in the state.

Data on investment in turkey production are available in (25). These were also based on a single county only (San Benito) and reflected conditions

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[1] Let K = gross private capital formation originating in UC 25 divided by gross private capital formation originating in UC 17, 18, 19, 21, 26, and 28; and let P_1 = the proportion of capital invested by UC 1 and originating in UC industries other than UC 29-30, which is allocated to UC 25 (trade and transportation margins). Then:

$$P_1 = \frac{K}{1 + K} .$$

[2] Here, all capital coefficients (in purchaser's value) were adjusted down on the assumption federal and state taxes were levied on all capital goods, including construction. Recall that no trade and transportation margin was considered for the construction coefficient.

in the year of 1957. Reliability of the estimates is therefore similar to the reliability of estimates for broiler production.

The preliminary aggregative estimate of the construction capital coefficient was adjusted down as explained under UC 1, and all capital coefficients were then transformed to producer's value to yield the final estimates of capital coefficients for UC 2.

UC 3.--Values of investment and output per cow for market and manufacturing milk production were available in (41). Separate capital coefficients for the two types of milk were derived first. The separate coefficients were then combined into a weighted average using commercial production of milk fat, available in the same source, as weights.

The estimate of the construction capital coefficient was adjusted down to allow for rented nonresidential farm buildings, and all coefficients were transformed to producer's value as explained in UC 1.

UC 4-UC 6 and UC 9.--These are field crop industries. UC 4, UC 6, and UC 9 are aggregates of several crops each while UC 5 consists of a single crop--cotton. Data on investment and outputs for individual crops were available in two main sources. The first source is a relatively detailed study on cotton farms in some parts of the San Joaquin Valley. The geographical regions covered in this study are major centers of production of field crops and vegetables. Results of the study were reported in (18), (19), (20), (21), (22), (23), and (32). The second source is R. L. Adams' Farm Management Crop Manual (1). Figures presented in this source apply to a broader geographical region but are based on meager statistical information.

In deriving the desired estimates of capital coefficients, corresponding coefficients were first developed for individual crops. These were then aggregated by UC industries using the individual crops' gross domestic outputs, reported in (35), as weights. In the San Joaquin Valley study, capital requirements were for multiple-crop farms. Allocation of total farm investment to individual crops was therefore necessary and was made according to the annual use of capital goods in the production of the various crops. In deriving estimates of capital coefficients from Adams' data, per-acre investment in any given crop was calculated according to the annual use of the equipment on an acre of the crop as compared to total annual use of the particular equipment. In some cases, capital coefficients derived from these two sources differed materially. Estimates based on the San Joaquin Valley study were usually higher than the estimates based on Adams' Manual. A U. S. Department of Agriculture study on the annual use of farm machinery (48) suggested that use of equipment is underestimated (and investment thus overestimated) in the San Joaquin Valley study, while it is overestimated by Adams' Manual. Investment figures in the two sources were, therefore, adjusted to conform more nearly to the annual use reported in (53) so as to reconcile them and obtain the figures used here.

Since capital requirements for irrigation systems are regarded as inputs to UC 51 ("irrigated land" auxiliary activity), these were excluded from the capital estimates. On the other hand, costs of establishing stands of perennial crops (alfalfa, irrigated pasture, asparagus, etc.) were regarded as investment goods originating in the same UC industry (for example, investment in alfalfa stand originates in UC 9). However, such an approach has one shortcoming: namely, expansion of perennial crops is restricted by the capacities of the UC industry of origin which is the very same industry to which the crop belongs. Such a restriction is in reality ineffective. The corresponding capital coefficients were therefore allocated to secondary industries of origin according to the flow inputs of these industries to the primary industry of origin (for example, investment in alfalfa stand was assumed to originate in industries whose outputs serve as flow inputs to UC 9).

Since the output of UC 6 has been valued at f.o.b. shipping point prices where vegetables are already packed and loaded, it was necessary to include investment in hauling and packing facilities with the capital coefficients of UC 6. No data on investment in these facilities in California during 1954 were available. Estimates were, therefore, developed in a rather indirect way. Data on investment requirement per dollar of annual charges for hauling, packing, and intermediate storing of onions in Oregon were available in (27). Similar data for fresh fruit hauling and packing facilities were provided by J. Stollsteimer, formerly of the Giannini Foundation. Hauling and packing charges per unit output, as well as prices, of fresh market vegetables were available in (1). Assuming hauling and packing charges to bear the same relation to investment requirements in all vegetables as in fruits, it was possible to obtain estimates of capital coefficients for hauling and packing facilities for house-packed fresh market vegetables (relation of annual charges to investment in potato-packing plants were assumed to be similar to those of onions). Investment requirements for field-packed vegetables were assumed to have the same capital structure as those for cabbage. No investment in packing facilities for processed vegetables was considered. Individual vegetables' capital coefficients for hauling and packing facilities were combined to form industry capital coefficients by calculating the total capital requirements for hauling and packing facilities (for fresh market vegetables only) and dividing this total by the overall gross domestic output of UC 6. The resulting estimates were then combined with UC 6 capital coefficients derived earlier for the production phase only.

Preliminary estimates of construction capital coefficients for UC 4, UC 5, UC 6, and UC 9 were adjusted for rented constructions, and all capital coefficients were then transformed to producer's value as described under UC 1.

UC 7 and UC 8.--UC 7 and UC 8 both involve large investments in establishing orchards. As before, the cost of establishing the orchards was regarded as capital goods originating in the industries where these goods are used. Investment in citrus and other fruit orchards was further distributed to the industries supplying flow inputs to UC 8 and UC 7, respectively.

Data on capital requirements by individual species and varieties were available in (1). Total annual use of farm equipment, available in (1), was corrected according to use figures presented in (53). Per-acre investment in any given fruit crop was calculated according to the annual use of the particular equipment on one acre of the crop. Capital coefficients were calculated using per-acre values of output available in (1). Capital coefficients for individual fruits were then aggregated by UC industries using their 1954 outputs, available in (8) and (35), as weights.

Since gross domestic outputs of UC 7 and UC 8 are valued at prices paid to farms at the first delivery point--that is, before fruits are packed--no investment in packing facilities was considered.

Construction capital coefficients were adjusted for rented construction, and all preliminary coefficients were then transformed to producer's value by the procedure described under UC 1.

UC 10.--Data allowing direct derivation of capital coefficients for UC 10 were available for the fishing subsector only. Indirect estimates were therefore derived on the basis of similarity between the subsectors of UC 10 and other agricultural industries. Thus, legume seeds, grass seeds, and oil crops were considered comparable to UC 4; sugar beet, vegetable seed, greenhouse, nursery, and miscellaneous crops similar to UC 6; and horses and mules were assigned the same capital coefficients as UC 1. Capital coefficients by EM industries of origin for the fishing subsector were available in (29). These were aggregated by UC industries of origin and transformed to producer's value by the general procedure used for this transformation in UC 1. Capital coefficients (in producer's value) of all subsectors were then aggregated using their gross domestic outputs, available in (35), as weights.

Nonagricultural Sectors

UC 11-UC 15, UC 18, UC 21, UC 22, UC 24-UC 26, and UC 29-30.--Estimates of capital coefficients for these industries are based primarily on a study of capital requirements for the expansion of industrial capacity published by the U. S. Bureau of the Budget in 1953 (29). Coefficients developed in this study are with reference to the EM 192, 1947, prepared by the U. S. Bureau of Labor Statistics and are thus for the United States as a whole. Capital coefficients for UC industries were obtained by the following procedure. Capital coefficients of individual purchasing (for investment purposes) EM industries were first aggregated by UC industries of origin. The resulting coefficients were then aggregated by purchasing UC industries using as weights the 1954 outputs of EM industries in California. Estimates of these outputs for EM industries corresponding to UC 11-UC 15, UC 18, UC 21,UC 22, UC 24, and UC 29-30 are available in (35). No such output figures for EM industries corresponding to UC 25 were available on a state basis; it was therefore assumed that the output composition of UC 25 in California was the same as in the United States. Gross domestic outputs of the component EM industries were therefore adopted from the 1947 U. S. Bureau of Labor Statistics study (63). United States 1947 output data were then "projected" to 1954 with the objective of allowing for the increased importance of motorcar and air transportation as compared with railroad transportation during 1947 through 1954. This was accomplished by inflating the corresponding 1947 outputs by the relative rate of increase in gross national product generated in these sectors. Gross national product data were available in (73). Similarly, no output data for EM industries corresponding to UC 26 were available on a state basis. It was therefore assumed that the output composition in California is the same as in the United States. Relevant output figures were accordingly adopted from (63).

Expansion capital coefficients for EM 169 (railroad transportation), available in (29), were given separately for passengers and freight transportation.

An aggregated capital coefficient for EM 169 was therefore formed using as weights the 1955 revenues of all railroad companies in the United States in the two types of transportation. Revenue figures were available in (57). Additional information used in developing estimates of capital coefficients for EM 169 was available in (71).

Since estimates of capital coefficients adopted from (29) are defined with respect to output of the primary industry only, it was necessary to adjust down the preliminary estimates, obtained by aggregation, according to the transfer-in included in the gross domestic output of the industry. This was done in order to avoid overestimation of capital requirements based on output figures involving large transfer-ins.

The transformation of capital coefficients from purchaser's value to producer's value was essentially the same as the one used for the agricultural industries. Trade and transportation margins were calculated on the assumption that they bore the same relation to overall capital coefficients in producer's value (excluding coefficients originating in UC 25, UC 29-30, UC 31, and UC 32) as they did in UC 35 (gross private capital formation). Preliminary estimates of capital coefficients for the present industries typically involved coefficients representing investment originating in some EM transportation industries. A slight change in the calculation of trade and transportation margins was therefore required.[1]

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[1] Accordingly, the coefficients based on capital originating in UC industries other than UC 25, UC 29-30, UC 31, and UC 32 and invested in the jth UC industry were multiplied by a factor P_j to yield the trade and transportation margin. P_j was calculated according to:

$$P_j = \frac{K}{1 + K} - \frac{b_{25j}}{b_{pj}(1 + K)}$$

where

K = ratio of gross capital formation originating in UC 25 to the sum of gross capital formation originating in UC industries other than UC 25, UC 29-30, UC 31, and UC 32.

b_{25j} = preliminary estimate of capital coefficient invested directly by UC 25 in the jth UC industry.

b_{pj} = sum of preliminary estimates (in purchaser's value) of capital coefficients originating in UC industries other than UC 25, UC 29-30, UC 31, and UC 32.

Tax margins were calculated in the same way as described for UC 1.

UC 16, UC 19, and UC 20.--Capital coefficients for UC 16, UC 19, and UC 20 are based on a study made by the Harvard Economic Research Project (30). Estimates of capital coefficients, presented in (30), were first aggregated by UC industries of origin for each investing EM industry. Investing EM industries were then aggregated by UC industries using their 1954 California outputs as weights. Related output figures were available in (35). No trade and transportation margins had to be subtracted since the estimates of capital coefficients, presented in (30), were already net of trade and transportation margins. It was necessary, however, to adjust for transfer-ins and subtract tax margins from the preliminary estimates of capital coefficients as was done in other industries.

UC 17.--UC 17 consists of EM 17 (crude petroleum and natural gas) and EM 62-EM 64 (petroleum products, coke and products, and paving and roofing materials). Information on capital coefficients was available for EM 17 and EM 62 only. These two components of UC 17 produced about 98 percent of the industry gross domestic output during 1954. Capital coefficients based on EM 17 and EM 62 alone, therefore, may be taken as representative of UC 17.

Data on per-well capital requirements by EM industries of origin are given in (29). Annual per-well production of crude petroleum in California during 1947 was available in (56). Per-barrel price of crude petroleum in 1947 was derived from annual United States crude petroleum output and value figures quoted in (56). These figures were used in calculating the 1947 value of output per well in California. Capital coefficients for EM 17 were thus derived from per-well investment requirements and per-well value of output.

Capital requirements per barrel per day (in 1947 dollars) for petroleum refining, EM 62, by EM industries of origin were available in (29). These were used in determining the capital structure of EM 62. The overall capital coefficient was derived, however, from statistics published by the U. S. Internal Revenue Service (68). This information was based on accounting data and thus differed from other sources used in estimating the capital coefficients. The undepreciated value of depreciable assets in "petroleum and coal products" divided by the corresponding value of sales plus gross receipts from operations was regarded as the overall capital coefficient for EM 62. This overall coefficient was allocated to UC industries of origin according to the capital structure of EM 62 as derived from (29).

Capital coefficients (in purchaser's value) for UC 17 were obtained by aggregating the corresponding coefficients for EM 17 and EM 62 using their 1954 California outputs, quoted in (35), as weights. Transformation to producer's value was made by the general procedure already outlined.

UC 23.--UC 23 consists of EM 167 (electric light and power), EM 168 (natural, manufactured, and mixed gas), and EM 179 (telephone and telegraph) industries of the U. S. Bureau of Labor Statistics study.

The overall capital coefficient for EM 167 was derived as follows. Total undepreciated value of "electric utility plant" in 1947 in classes A and B, privately and publicly owned (excluding federal projects), was obtained from (67). Value of allocated investment in federal projects for 1947 was derived as a ratio estimated from the 1955 value of allocated investment quoted in (57) and the ratio of installed capacity in federal projects in the respective years. Related information was available in (57). Total value of United States investment in electric plant in 1947 was then divided by the gross domestic output of EM 167 quoted in (63). An overall capital coefficient for EM 167 equal to 3.66988 was thus obtained.

Capital coefficients in terms of 1947 dollars per kilowatt of capacity for distribution, transmission, hydroelectric power generation, and steam power generation were available in (29). These coefficients were combined to yield capital coefficients, in 1947 dollars per kilowatt capacity, for two electric-generating and distribution systems--that is, for a hydroelectric power generation system and for a steam power generation system.

Recalling that the United States overall capital coefficient of EM 167 is an aggregate of capital coefficients of hydroelectric and nonhydroelectric power generation systems, the next step was to disaggregate this coefficient into its components. This was accomplished by solving the two equations in the two unknown coefficients c_s and c_H:

$$dc_s + (1 - d)c_H = 3.66988$$

$$\frac{c_s}{c_H} = .884553$$

where

d = proportion of nonhydroelectric generation of total installed capacity for the United States in 1947.

c_s = unknown overall capital coefficient of nonhydroelectric generation systems.

c_H = unknown overall capital coefficient of hydroelectric generation systems.

$\frac{c_s}{c_H}$ was obtained as a ratio of the corresponding capital coefficients per kilowatt capacity derived from (29) as explained above.

The resulting estimates of the overall capital coefficients were then disaggregated by UC industries of origin according to the composition of per kilowatt coefficients derived from (29).

An overall capital coefficient for EM 168 was obtained from balance sheet statements of the United States gas industry, available in (3). Data used were averages of the period 1946-1950. An overall capital coefficient was obtained as a ratio of the undepreciated value of "total utility plant" to total value of "operating revenue." The resulting coefficient equaled 3.159057. Further disaggregation of the overall capital coefficient of EM 168 by UC industries of origin was accomplished using the composition of investment in "natural gas transportation and distribution" systems, available in (29). These components of the system constitute about 86 percent of total utility plant (3).

Capital coefficients, in 1947 dollar value of investment per 1947 dollar value of output, for EM 179 by EM industries of origin were available in (29). These were aggregated by UC industries of origin. The resulting estimates of capital coefficients for EM 167 (hydropower and nonhydropower generation), EM 168, and EM 179 were further aggregated using their 1954 California outputs as weights. Total output of EM 167 was subdivided, for this purpose, into value of output produced by hydroelectric and steam-generating systems, respectively. The division was made on the basis of total electricity produced by the two systems in California during 1954. Related data were available in (15). The preliminary estimates thus obtained were then transformed to producer's value according to the procedure previously outlined under UC 1.

UC 27, UC 28, UC 31, UC 32, and UC 37.--These industries are assumed to have no capital stocks. Such an assumption is quite obvious in the case of UC 27 and UC 28 but is not so clear for UC 31, UC 32, and UC 37. To be sure, both government and households do invest in capital goods. But, in analogy with the national accounts, households expenditures on durable consumer goods are regarded as consumption. Similarly, purchases of capital goods by UC 31 and UC 32 are regarded as ordinary components of current government expenditures.

The Irrigated Land Activity

Capital coefficients of irrigated land represent the 1954 value of investment in irrigation systems required for the conversion of an acre of unirrigated land into irrigated land. In estimating these requirements, it was hypothesized that future expansion of water supply would occur mainly in the form of imported surface water. It was not clear, however, how many additional wells would be required in future expansion of irrigated land. The assumption that the frequency of wells in newly developed irrigated land would resemble the 1954 frequency was finally adopted. This assumption was regarded as plausible since recharge of groundwater and subsequent pumping were expected to be an integral part of future irrigation activities. In addition, some pumping plants are likely to be required as an ordinary component of farm water distribution systems.

Preliminary estimates of capital coefficients for irrigated land were obtained from the "synthesized irrigated farms" developed for various regions of the San Joaquin Valley--(21), (22), (23), and (32). Capital coefficients for individual regions and farm types were then aggregated using the acreage of irrigated land in the particular region-farm type as weights. Acreage of irrigated land by region and farm type was available in the sources mentioned above. The aggregated coefficients finally were transformed to producer's value by the general procedure outlined under UC 1. The results appear in Table 5.

C. Derivation of Inventory Coefficients for Individual Sectors

Agricultural Sectors

UC 1: Raw Materials and Goods in Process.--No information was available on this type of inventory for UC 1. Raw materials and goods-in-process coefficients for UC 1 were therefore calculated on the assumption that one-month utilization of storable flow inputs is ordinarily carried.

UC 1: Finished Goods.--Total value of beef cattle, hogs, and sheep and lambs on farms was regarded as the finished goods inventory of UC 1. Total value of livestock on farms on January 1, 1954, and on January 1, 1955, was averaged to yield an estimate of the mean level of inventories during 1954. Data on number of hogs and sheep and lambs on California farms on January 1, 1954, and January 1, 1955, and corresponding values per head were available in (4). Data on beef cattle were less readily available, and it was necessary to obtain indirect estimates of values per head. To this effect, it was assumed that values per head of beef cattle, as well as those of calves and heifers kept for milk, varied over time in the same proportion as values per head for all cattle. This led to the following two equations in two unknowns:

$$V_{11}^{54} + N_{12}^{54} P_{12}^{54} + N_{20}^{54} P_{20}^{54} = V_T^{54}$$

$$V_{11}^{55} + N_{12}^{55} \left(\frac{P_T^{55}}{P_T^{54}} \right) P_{12}^{54} + N_{20}^{55} \left(\frac{P_T^{55}}{P_T^{54}} \right) P_{20}^{54} = V_T^{55}$$

where

V_{11}^t = value of milk cows in t.

N_{12}^t = number of milk calves and heifers in t.

P_{12}^t = value per head of milk calves and heifers in t.

N_{20}^t = number of beef cattle in t.

P_{20}^{54} = value per head of beef cattle on January 1, 1954.

P_T^t = average value per head of all cattle in t.

V_T^t = total value of all cattle in t.

t = 1954 or 1955.

The unknowns in the system were P_{12}^{54} and P_{20}^{54}. Values of all other variables were available in (4). It was therefore possible to solve for the unknown values per head and use these in evaluating the total inventory of finished goods carried by UC 1.

The inventory coefficient for UC 1 was then obtained as the ratio of the total finished goods inventory to the corresponding gross domestic output available in (35).

UC 2: Raw Materials and Goods in Process.--Estimates of total value of raw material inventories carried by egg producers in California per hen raised in 1948 and 1959 were available in (42) and (39), respectively. The overall inventory coefficient for 1954 was therefore derived as a ratio of the mean value of 1948 and 1959 inventories per hen to the 1954 value of output per hen quoted in (39). The overall raw materials and goods-in-process coefficient was then disaggregated by UC industries of origin according to the flow inputs to UC 2. No separate information was available for broiler and turkey production. It was therefore assumed that these activities have the same raw material coefficient as the egg and chicken production activities.

UC 2: Finished Goods.--The average annual value of fowls on farms (poultry stock) is regarded as the finished goods inventory of UC 2. Included are fowls of all ages.

Estimates of investment in "poultry stocks" in egg and chicken production in California, 1948 and 1959, were available in (42) and (39), respectively. An estimate of finished goods inventory coefficient was therefore obtained according to the procedure followed in deriving the corresponding capital coefficients. Similar estimates for broiler and turkey production were derived using the concept of a "production period" and assuming that broiler and turkey production is carried out uniformly throughout the year.[1] If one assumes that the production of 1/365 of the annual output is initiated daily, then, given a production period of p_j days in the jth activity, a stationary inventory implies an inventory coefficient c_j equal to:[2]

$$c_j = \frac{p_j + 1}{730} \quad .$$

Having thus obtained the finished goods coefficient for egg and chicken, broiler, and turkey production, the overall industry coefficient was obtained

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[1] This assumption is more or less acceptable for broiler production, but its validity is more questionable for turkey production.

[2] Let X_j = the annual value of output and assume linear growth; then a stationary state implies that, at any point in time, there are p_j inventories of finished goods corresponding to p_j different dates of initiation--the value of inventories initiated n days earlier being $\frac{n}{p_j 365} X_j$. The overall inventory coefficient is therefore:

$$c_j = \frac{1}{X_j} \cdot \sum_{n=1}^{p_j} \cdot \frac{n}{p_j} \cdot \frac{X_j}{365} = \frac{p_j + 1}{730} \quad .$$

as a weighted average of the individual activities using their gross domestic output, available in (35), as weights.

UC 3: Raw Materials and Goods in Process.--Data on inventories of raw materials and gross income per milking cow for market and manufacturing milk production were available in (41). Separate inventory coefficients for market and manufacturing milk were therefore derived first. These were then aggregated using California commercial production of the two types of milk during 1950, presented in (41), as weights. The resulting coefficient was finally segregated by UC industries of origin according to input flows to UC 3.

UC 3: Finished Goods.--Dairy livestock--including cows, bulls, calves, etc.--were regarded as finished goods inventories of UC 3. Data on value of livestock and gross income for market and manufacturing milk were available in (41). The separate inventory coefficients calculated from these data were aggregated using commercial output of the two types of milk in California during 1950 as weights to yield the finished goods coefficient for UC 3.

UC 4-UC 9: Raw Materials and Goods in Process.--Most agricultural production processes are characterized by a long period during which flow inputs are being invested and a relatively short period during which the crop is harvested. At any point in time, the value of the unharvested crop represents a stock of capital. This stock is most appropriately identified as an inventory of goods in process. For the purpose of the present study, it has been assumed that the productive process is uniform throughout the year; that is, the rate of input per unit activity per day is constant over the growth period, and 1/365 of the annual output is initiated daily. The normal inventory of raw materials and goods in process is then identified with the stationary value of crops in the field. Let p_j = the duration in days of the growth period for the jth industry, and let X^*_{ij} = the value of output originating in the ith industry and purchased by the jth crop for preharvest use; then the corresponding goods-in-process inventory coefficient c_{ij} is given by:[1]

$$c_{ij} = \frac{(p_j + 1)\, X^*_{ij}}{730 X_j}$$

where X_j is gross domestic output of the jth industry.

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[1] The formula for c_{ij} was derived in a fashion similar to that for c_j in footnote 2, p. 69.

The uniformity assumption involves the notion that there are always some crops growing and that, for a given level of annual output, each day of the year has the same value of crops growing. Clearly, this is invalid for an individual crop. However, for an industry containing many varieties of crops, the approach can be defended. At any rate, given data limitations, this seems to be the only operationally feasible approach.

For this approach, there may be some concern about "double counting," with inputs possibly showing up as both output and inventory. This argument does not seem applicable in an input-output (or growth model) framework. Within the span of a year, there is some output which has been initiated in the previous year and some inputs which will eventuate in output the following year (given the uniformity assumption). The amount of this "overlap" relative to total output is exhibited explicitly in the c_{ij} and can be viewed as a stock of capital as of any instant of time, including the end of the given year.

As an illustrative example, consider a "year" consisting of three days, with inputs of one unit applied on days 1 and 2 and with output of two units obtained on day 3. Assume further that there are three "tracks," with initial investment in track 1 on day 1, in track 2 on day 2, and in track 3 on day 3 with subsequent investment on days modulo 1, 2, and 3. In diagrammatic form we have:

Track	Year 1[a]			Year 2 and all subsequent years		
	Day			Day		
	1	2	3	1	2	3
	inputs into track and output					
1	1	1	X[b]	1	1	X
2		1	1	X	1	1
3			1	1	X	1

a/ Initial year.

b/ X = output of two units.

In the example, there is always an "initial" investment on hand which is carried forward in time. Year 1 contains five units of input and two units of output. Thereafter, each year has six units of input and six units of output, so there is always an amount of three units of input "left over" which is being carried forward in time. This amount is equivalent to the goods in process of the present study. At any point in time (or day), this amount of unharvested input (three units) is on hand.[1]

To obtain the goods-in-process inventory coefficient c_{ij} of the equation above, it was first necessary to derive estimates of preharvest inputs X^*_{ij}. To this effect, it was assumed that the inputs used during harvest time originated in the household sector, UC 37, and in "other manufacturing" industries, UC 21, only.[2] In evaluating the validity of this assumption, recall, however, that all labor costs and most of the equipment charges are credited by Martin (35) to UC 37 as wages, depreciation, and interest costs. Data on harvesting costs by UC industries of origin per unit value of output were obtained for individual crops from (1). These were then aggregated by UC industries using corresponding 1954 California values of outputs as weights. The latter information was available in (5), (7), (8), (35), and (58). Let h_{ij} = the "harvest technical coefficient" (representing the value of input originating in the _i_th industry and used in harvesting a dollar output of the _j_th industry); then the preharvest input X^*_{ij} is computed according to:[3]

$$X^*_{ij} = X_{ij} - h_{ij}X_j$$

where X_{ij} is total input flow from _i_th industry to _j_th industry, as given in (35).

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[1] It should be noted that this approach is specific to the conditions of the present problem. In other problems, alternative formulations may be more reasonable. Thus, if one were working with an individual crop, with time span involved defined as initiation of production through harvest, goods in process might not be a useful construct. Put more generally, the uniformity assumption may be a bad assumption in models where the basic time period is shorter than a year but would appear to be operationally acceptable in models based on annual data.

[2] Inputs from UC 21 primarily represent materials utilized in the harvesting and packing operations.

[3] For UC 21 it sometimes happened that $X_{ij} < h_{ij}X_j$; in this case, X^*_{ij} was set equal to zero.

The growth period was calculated as follows. For all perennial crops it was clearly 365 days. Data on the annual field crop growth period were available in (7). Similar information on annual vegetables was available in (48) and (51). The number of days between the midplanting period and the midharvest period was in all cases considered as the growth period. The growth periods for individual crops were then aggregated by UC industries. The resulting single-growth period for each UC industry is thus a weighted average where the 1954 California values of outputs of individual crops served as weights. Output figures were available in (5), (7), (8), (35), and (58).

Since costs of establishing stands of alfalfa and pasture were already considered as capital goods, they were excluded from the calculation of goods-in-process inventories for UC 9. In the case of fruit trees, however, inventory of goods in process was developed according to the general procedure in spite of the fact that costs of establishing orchards had already been considered as capital goods. This is because fruit trees, in contrast to alfalfa and pasture, are characterized by a relatively short harvesting period.

Coefficients of raw materials and goods in process, calculated on the basis of the growth period concept, mainly represent the value of goods in process. It is therefore necessary to include among the inventory's components outputs which are typically unstorable. Thus, all preharvest flow inputs were considered in allocating the inventory coefficient to industries of origin.[1]

UC 4: Finished Goods.--Values of California stocks of grains as of October 1, January 1, April 1, and June 1, 1954, were available in (7). Values of output of UC 4 carried by other UC industries were subtracted from the annual average inventory of all grains. This yielded the value of the finished goods inventory carried by UC 4. Dividing the inventory figure by the gross domestic output of UC 4 gave the finished goods inventory coefficient of UC 4.

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[1] It may be noted that animals in herds in UC 1-UC 3 could have been classified as goods in process (corresponding to the classification of crops in the field as goods in process) rather than as finished product. However, if this had been done, the industry origin of the animals could have been defined as the same industry as the industry destination. The corresponding inventory coefficient would then appear on the main diagonal of the inventory coefficient matrix. But this is the same result as is obtained by treating herds as finished goods, since finished goods appear on the main diagonal, as is noted on page 39. Finally, unlike the typically unstorable crop goods in process, animals in herds can be viewed as "storable."

UC 5: Finished Goods.--United States carry-over of commercial cotton on August 1, 1954, was available in (50).[1] California carry-over was derived from United States carry-over on the assumption that carry-overs were proportional to production. California cotton stocks were then evaluated using the 1954 average price received by growers in California reported in (50). The corresponding coefficient was then obtained by dividing the value of 1954 California stocks by the gross domestic output of UC 5.

UC 6: Finished Goods.--Statistical data were available for onion stocks only. Quantities of onions held in common storage in California were reported in (52), and cold storage holdings were derived from data available in (49). Data in the latter source were for the Pacific region as a whole. California stocks were therefore derived on the assumption that stocks are proportional to outputs. The corresponding inventory coefficient was obtained by dividing the value of the California holdings by the gross domestic output of UC 6.

UC 7: Finished Goods.--End-of-month cold storage holdings of various fresh fruits and nuts in the Pacific region were reported in (49). California holdings were assumed to be proportional to the state's relative output. State and regional outputs and prices for 1954 were available in (8) and (58). The value of finished goods inventories of UC 7 was then obtained by subtracting values of inventories originating in UC 7 and carried by UC 25 from California's annual average of monthly fresh fruits and nuts inventories. The corresponding coefficient was obtained by dividing the inventory figure by the gross domestic output of UC 7.

UC 8: Finished Goods.--Finished goods inventory data were available for lemons only. Monthly data on quantities of lemons stored in California were reported in (44). Prices received by growers are quoted in (47). The value of finished goods inventories carried by UC 8 were obtained by subtracting the value of output of UC 8 carried by UC 25 from the annual average of the monthly storage data. The corresponding inventory coefficient was obtained as a ratio of the value of inventories to the gross domestic output of UC 8.

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[1] August 1 stocks represent the lowest level of cotton stocks since the new crop is not yet in. In 1954, however, cotton stocks were in general much higher than the normal free market levels because of large Commodity Credit Corporation carry-overs. The biases in the estimate thus operate in compensatory directions.

UC 9: Finished Goods.--Value of California on-farm inventories of hay on January 1 and May 1, 1954, was reported in (7). The mean value of these figures was regarded as the inventory of finished goods of UC 9. The corresponding inventory coefficient was derived, as before, by dividing UC 9 inventory by the corresponding gross domestic output.

UC 10: Raw Materials and Goods in Process and Finished Goods.--Inventory coefficients were obtained from corresponding coefficients of other agricultural industries similar to the various subsectors of UC 10. An overall inventory coefficient for the "fishing" activity was obtained from (68). It was assumed that it consists of raw materials only. Allocation to industries of origin was made according to storable flow inputs to the fishing subsector, available in the 1947 U. S. Bureau of Labor Statistics study (63). The aggregation procedure was virtually the same as the one used for the capital coefficients of UC 10.

Nonagricultural Sectors

UC 11-UC 21.--Values of United States inventories of raw materials and goods in process and of finished goods for the end of 1953 and 1954 were reported in (61). The averages of the two sets of figures were regarded as United States inventories carried by the manufacturing industries during 1954. To get the corresponding California inventories, it was assumed that levels of inventories are proportional to gross domestic outputs of the primary industries. Related United States figures were derived from (61) as the sums of values of shipments plus changes in finished goods inventories.[1] Analogous data for California were available in (35). Values of California inventories of raw materials and goods in process were then allocated to UC industries of origin according to flows of storable inputs and UC 25 services to the industries carrying the inventories.

Dividing the values of various inventories by the gross domestic output of the industry yielded the related estimates of inventory coefficients.

UC 22-UC 24, UC 26, and UC 29-30.--Inventory coefficients of these industries are based on data available in (68). Classification of industries in (68) is according to the SIC classification. It was possible, therefore, to relate the reported data to corresponding EM industries. Hence, inventory coefficients were developed first for EM industries and then aggregated by UC industries. In developing the coefficients, gross domestic output of an industry was generally identified with the sum of "gross sales" plus "gross receipts from operations" presented in (68). The output of EM 181 (banking, finance, and insurance), however, was identified with total costs incurred by the industry.[1] Having estimated the overall inventory coefficients for individual EM industries, the next step was to aggregate them by UC industries. Aggregation was accomplished using the corresponding outputs, available in (35), as weights. For UC 26 no such outputs are given in (35). United States outputs reported in the 1947 U. S. Bureau of Labor Statistics study (63) were therefore used as weights.

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[1] In the few cases where shipment data were incomplete, estimates of outputs were developed on the basis of employment figures.

UC 22 was assumed to carry finished goods inventories only, while UC 23, UC 24, UC 26, and UC 29-30 were assumed to carry no such inventories.[2] In addition, EM 183 (real estate and rentals) was assumed to carry no inventories whatsoever. Overall inventory coefficients of UC 23, UC 24, UC 26, and UC 29-30 were therefore segregated by UC industries of origin according to the storable flow inputs and UC 25 services distributed to these industries.

UC 25.--Value of merchandise carried by the retail and wholesale subsectors is regarded as the raw materials and goods-in-process inventory. No finished goods inventories are carried by the trade subsectors, and the same holds true for the transportation industries.

Values of inventories carried by wholesale trade in California during 1954 were reported in (60). Segregation of inventories by UC industries of origin was according to the type of business carrying the inventories. Whenever the reported type of business corresponded to several UC industries of origin, the corresponding inventory was allocated to these industries according to their gross domestic outputs. In the case of vegetables and fruits, however, allocation was according to purchases of the household sector from UC 6, UC 7, and UC 8, respectively.[1]

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[1] For "total finance," these costs include costs of goods sold, cost of operations, compensation of officers, rent paid on property, depreciation and amortization, advertising, contribution to pension plans, and other employees' benefit plans. For "insurance," other deductions representing, among other costs, insurance claim payments were also included as components of output.

[2] A sizable inventory of goods in process ordinarily exists in the form of unfinished structures. This inventory was not included in UC 29-30 inventory coefficients since it is more appropriately incorporated in any growth model by using gestation lags. For additional discussion, see supra, p. 31.

United States inventories carried by retail trade during 1954 were reported in (72). Data are by types of stores. A finer breakdown of United States inventories by types of stores was made on the assumption that, with a given type group, inventories are proportional to annual sales. Data on United States and California sales were available in (59). Inventories carried by retail trade in California during 1954 were estimated from United States inventories again on the basis of sales. Whenever a type of retail store corresponded to several UC industries of origin, inventories were segregated according to purchases of the household sector from the respective UC industries.

An inventory coefficient for the transportation industries was obtained from (68) as the ratio of "inventories" to the sum of gross sales plus gross receipts from operations. Total value of inventories carried by the transportation industries was estimated on the basis of the overall coefficient and the assumption that gross domestic outputs of the transportation industries in 1954 bore the same relation to the gross domestic outputs of the trade industries as it had in the 1947 U. S. Bureau of Labor Statistics study. The overall value of inventories was further segregated by UC industries of origin according to the distribution of storable flow inputs and UC 25 services to transportation industries as presented in (63).

Inventories carried by wholesale and retail trade were then combined with inventories carried by the transportation industries to yield the total inventories, by industry of origin, carried by UC 25. Inventory coefficients were finally obtained by dividing the total inventory figures by the gross domestic output of UC 25.

UC 27, UC 28, UC 31, UC 32, and UC 36-37.--These industries are assumed to carry no inventories whatsoever. The reasons for such an assumption have been discussed in the corresponding section dealing with expansion capital coefficients for these industries.[2]

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[1] Household purchases rather than gross domestic outputs served as the allocation base inasmuch as processors of fruits and vegetables were assumed to purchase directly from the growers.

[2] *Supra*, pp. 56-67.

D. Derivation of Replacement Flows for Individual Sectors

Initial Calculations

UC 1.--Life expectancy of various capital goods invested in beef cattle, hogs, and sheep production for the years 1951-52 were available in (2). Values of annual depreciation were derived from the corresponding investment figures on the basis of their life expectancy. Annual depreciation was then summed by UC industry of origin and divided by the associated outputs given in (2). The resulting depreciation coefficients for the individual production activities were then aggregated to yield the industry depreciation coefficients. Outputs of the various activities, available in (35), served as weights in the aggregation. The construction depreciation coefficient was adjusted down to allow for rented construction, and all depreciation coefficients were transformed from purchaser's value to producer's value in the same way as the respective capital coefficients.[1] Replacement flows were then obtained by multiplying the final depreciation coefficients by the gross domestic output of UC 1.

UC 2.--Replacement requirements for UC 2 were derived from information on capital requirements and life expectancy of capital goods invested in egg and chicken, broiler, and turkey production. This information was available in (25), (28), (39), and (42). The separate replacement coefficients for eggs and chickens, broilers, and turkeys were then aggregated using their gross domestic outputs, available in (35), as weights. The aggregative construction coefficient was adjusted down for rented-farm construction, and all coefficients were transformed to producer's value in the same way as the corresponding capital coefficients. Replacement flows were obtained by multiplying the resulting coefficients by the gross domestic output of UC 2.

UC 3.--Information on investment costs and life expectancy of equipment and buildings in the dairy industry in California was available in (41). Data were for market milk and manufacturing milk and were on a per-cow basis. Estimates of replacement coefficients were first developed separately for the two types of milk using per-cow income figures available in the above source. The separate coefficients were then aggregated using corresponding California commercial production of milk fat as weights. The construction coefficient was finally adjusted down to account for rented farm buildings, and all coefficients were transformed to producer's value by the general procedure applied to capital coefficients. Replacement flows were obtained by multiplying the replacement coefficients by the gross domestic output of UC 3.

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[1] Ibid.

UC 4-UC 6 and UC 9.--Replacement coefficients for UC 4-UC 6 and UC 9 were estimated on the basis of information available in (1), (18), (19), (20), (21), (22), (23), and (32). These are the sources used in deriving the capital coefficients. Estimates of replacement coefficients were derived by a procedure similar to the one used in estimating the capital coefficients. Replacement coefficients were first obtained for individual crops and then aggregated by UC industries according to the gross domestic outputs of the particular crops. Calculations of depreciation coefficients for individual crops involved the following steps:

1. Depreciation rates available in the sources mentioned above were applied to the equipment, and improvements and buildings were used in the production of each crop to yield the corresponding estimates of replacement flows.[1]
2. Replacement flows for each crop were then summed by UC industries of origin and divided by the corresponding returns to yield the replacement coefficients.

Replacement of perennial crops, which are regarded as expansion capital stocks, was not calculated since it had already been included by Martin as a current flow.

In aggregating the individual crop coefficients, those based on the San Joaquin study were preferred to those based on Adams' Manual (1). The first, rather than the second, was always adopted whenever a choice was possible.

In calculating the replacement coefficients of UC 6, crop coefficients were combined with corresponding hauling and packing replacement coefficients since output of UC 6 had been evaluated at f.o.b. shipping point prices. Replacement coefficients for hauling and packing facilities were obtained using the life expectancy of capital goods by industry of origin presented in (34) and the capital coefficients for hauling and packing facilities. Estimation of the latter is explained in the section dealing with capital coefficients of UC 6.[1/]

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[1] The estimation of capital goods used in production of the various crops is explained in the corresponding section on capital coefficients; see ibid.

Replacement coefficients thus obtained for UC 4-UC 6 and UC 9 were finally adjusted for rented-farm construction and then transformed to producer's value by the general procedure used in transforming the capital coefficients.

UC 7 and UC 8.--Data on investment requirements and life expectancy of various capital goods used by UC 7 and UC 8 were available in Adams' Manual (1). Data were given by individual species and varieties of fruit trees. Replacement coefficients were therefore estimated first for individual crops and then aggregated by UC industries using as weights the gross domestic outputs of the particular crops. Replacement coefficients were estimated by applying the depreciation rates to the investment allocated to various crops (on per-acre basis) and then dividing the resulting per-acre replacement requirements by per-acre returns, available in (1).[2/] Gross domestic output figures used in aggregation were adopted from (8) and (35).

Replacement of orchards was not calculated since these had already been included by Martin in his current flow table. Construction replacement coefficients were finally adjusted down to allow for rented construction, and all coefficients were transformed to producer's value according to the general procedure developed for capital coefficients. Replacement flows were obtained by multiplying the replacement coefficients by the gross domestic outputs of UC 7 and UC 8.

UC 10.--No data allowing direct estimation of depreciation rates for UC 10 were available. Depreciation coefficients for subsectors of UC 10 were therefore derived on the basis of their similarity with other UC industries. The same approach was also adopted in estimating the capital and inventory coefficients for UC 10. Aggregation of the subsectors' coefficients was according to their outputs given in (35). Depreciation flows were then obtained from the aggregate replacement coefficients and the gross domestic output of UC 10.

[1/] Supra, pp. 59-61.

[2/] Allocation of investment is explained in the corresponding section on capital coefficients; supra, pp. 56-67.

UC 11-UC 26 and UC 29-30.--Depreciation flows for UC 11-UC 26 and UC 29-30 are based on the capital structure of the various industries and on the life expectancy of capital goods. It was generally assumed that the life expectancy of any capital good depends on its industry of origin rather than its industry of use. Estimates of life expectancy by industry of origin were available in (34) for the 1939, 96-industries model. There was some concern about the validity of the assumption of independence of life expectancy and industry of use. In addition, there was some question as to the current applicability of the estimates of life expectancy; that is, there was some concern that the estimates might be out of date.

Data published by the U. S. Internal Revenue Service (68) were therefore used to adjust the estimated replacement flows so that their consistency with the Internal Revenue data was assured. More specifically, let

D_{ij} = annual replacement flow from the *i*th industry to the *j*th industry (measured in purchaser's value).

Q_{ij} = the stock of capital originating in the *i*th industry and used by the *j*th industry (measured in purchaser's value).

T_{ij} = life expectancy of Q_{ij} as derived from (34).

X_j = output of the *j*th industry.

Now, define the replacement rate d_{ij}:

$$d_{ij} = \frac{D_{ij}}{Q_{ij}}$$

and the capital coefficient k_{ij} (in purchaser's value):

$$k_{ij} = \frac{Q_{ij}}{X_j} .$$

Then

$$D_{ij} = d_{ij}k_{ij}X_j = \frac{1}{T_{ij}} k_{ij}X_j .$$

It was assumed that estimates of d_{ij}, derived from (34), had to be adjusted by a factor c_j in order to conform to the U. S. Internal Revenue Service data; that is:

$$d_{ij} = c_j \frac{1}{T_{ij}} .$$

c_j was then estimated according to:

$$\hat{c}_j = \frac{D^*_j \sum_i k_{ij}}{Q^*_j \sum_i \frac{1}{T_{ij}} k_{ij}}$$

where

D^*_j = "depreciation and amortization" of the _j_th industry as reported in (34).

Q^*_j = the undepreciated value of "depreciable assets" owned by the _j_th industry as reported in (34).

Whenever a UC industry was an aggregate of several U. S. Internal Revenue Service industries, c_j was estimated on the basis of relations between depreciation and output; that is, suppose the _j_th UC industry is an aggregate of a set S_j of Internal Revenue industries so that its output X_j is:

$$X_j = \sum_{s \in S_j} X_{sj} .$$

Then, c_j was estimated as:

$$c_j = \sum_{s \in S_j} \frac{\frac{D^*_{sj}}{X^*_{sj}} \frac{X_{sj}}{X_j}}{\sum \frac{1}{T_{ij}} k_{ij}}$$

where

D^*_{sj} and X^*_{sj} = the respective estimates of depreciation and output of the _s_th industry as derived from (34).

X_{sj} = the corresponding California output available in (35).

Estimates of depreciation flows were thus obtained according to:

$$D_{ij} = \hat{c}_j \frac{k_{ij} X_j}{T_{ij}} .$$

Replacement flows were derived only for those industries whose outputs were distributed by Martin to UC 35 (gross private capital formation).

Estimates of life expectancies T_{ij} were derived for each UC industry on the basis of its capital composition by EM industry of origin; that is, suppose the jth UC industry is an aggregate of a set S_j of EM industries and the capital coefficient k_{sij} of the sth EM industry originates in a set P_{sij} of EM industries, then the life expectancy T_{ij} is estimated according to:

$$T_{ij} = \frac{k_{ij} X_j}{\sum_{s \epsilon S_j} X_{sj} \sum_{p \epsilon P_{sij}} \frac{1}{T_{psij}} k_{psij}}$$

where

T_{psij} = the life expectancy of capital originating in the pth element (EM industry) of the set P_{sij}.

k_{psij} = the corresponding capital coefficient.

Except for UC 25, all cj's were greater than unity--usually around 1.5.

The resulting estimates of replacement flows D_{ij} were in purchaser's value. It was necessary, therefore, to transform them to producer's value. This transformation was accomplished according to the general procedure developed for a similar transformation of capital coefficients.

UC 27, UC 28, UC 31, UC 32, and UC 37.--Since these industries are assumed to have no capital stocks, no replacement flows had to be calculated.

The Irrigated Land Activity

Replacement flows for irrigated land were estimated as follows. Replacement coefficients were first developed on the basis of the estimated capital coefficients (purchaser's value) and life expectancies of various irrigation equipment available in (21), (22), (23), and (32). The estimated coefficients were then transformed to producer's value by the general procedure developed for capital coefficients. Replacement flows were finally obtained by multiplying the 1954 acreage of irrigated land, available in (58), by the replacement coefficients. The results appear in Table 5.

General Adjustment of Replacement Flows

The sums of estimated replacement flows by industries of origin did not show good agreement with corresponding figures in UC 35--the gross private capital formation sector. Thus, estimated replacement flows originating in UC 17, UC 18, UC 21, and UC 25 were greater than gross investment figures in UC 35, while replacement flows originating in UC 29-30 appeared too small when compared with the corresponding gross investment figure.[1] It was therefore necessary to adjust the estimates so as to achieve better agreement between the two sets of estimates.[2] The adjustment was made as follows. Replacement flows originating in UC 29-30 appeared to be too small and were therefore multiplied by $\frac{46}{40}$. This adjustment factor is somewhat arbitrary. It was chosen since the life expectancy of construction was generally taken to be 46 years, while 40 years seemed to be more appropriate in light of the above-mentioned comparison. Next, it was assumed that total replacement flow in California constituted the same proportion of gross investment as capital consumption allowances were of gross investment in the United States during 1954. Data on United States gross investment and capital consumption allowances were available in (73). Overestimated replacement flows (originating in UC 17, UC 18, UC 21, and UC 25) were adjusted down so as to assure the same ratio of overall net investment to gross investment in California as it was in the United States.

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[1] Overestimation of replacement flows may imply disinvestment rather than error in estimation. Since 1954 net investment in the United States was positive and since California's growth rate has exceeded that of the United States in the recent past, we preferred to adjust the estimates rather than assume disinvestment.

[2] The disagreement between the two sets of estimates is to some extent due to differences in definitions. Our, rather than Martin's, estimates were therefore adjusted.

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